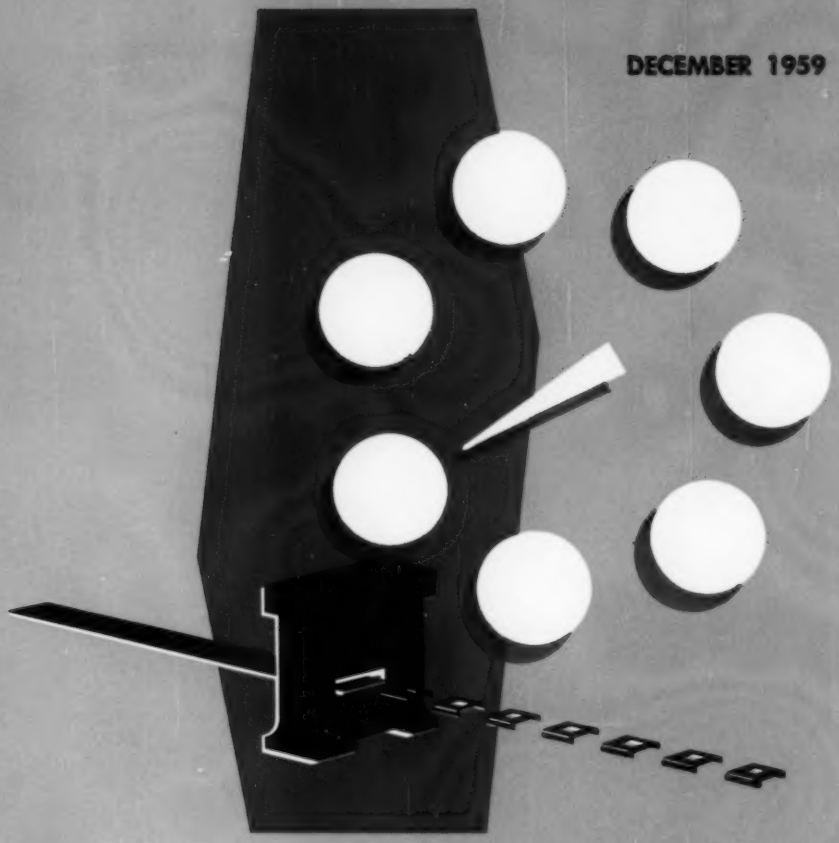
AUTOMATION

DECEMBER 1959



Automated Pressworking

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Making Insulating Board
- Programmed Nailing
- Synchronized Delay System
- Electronic Gaging and Sorting

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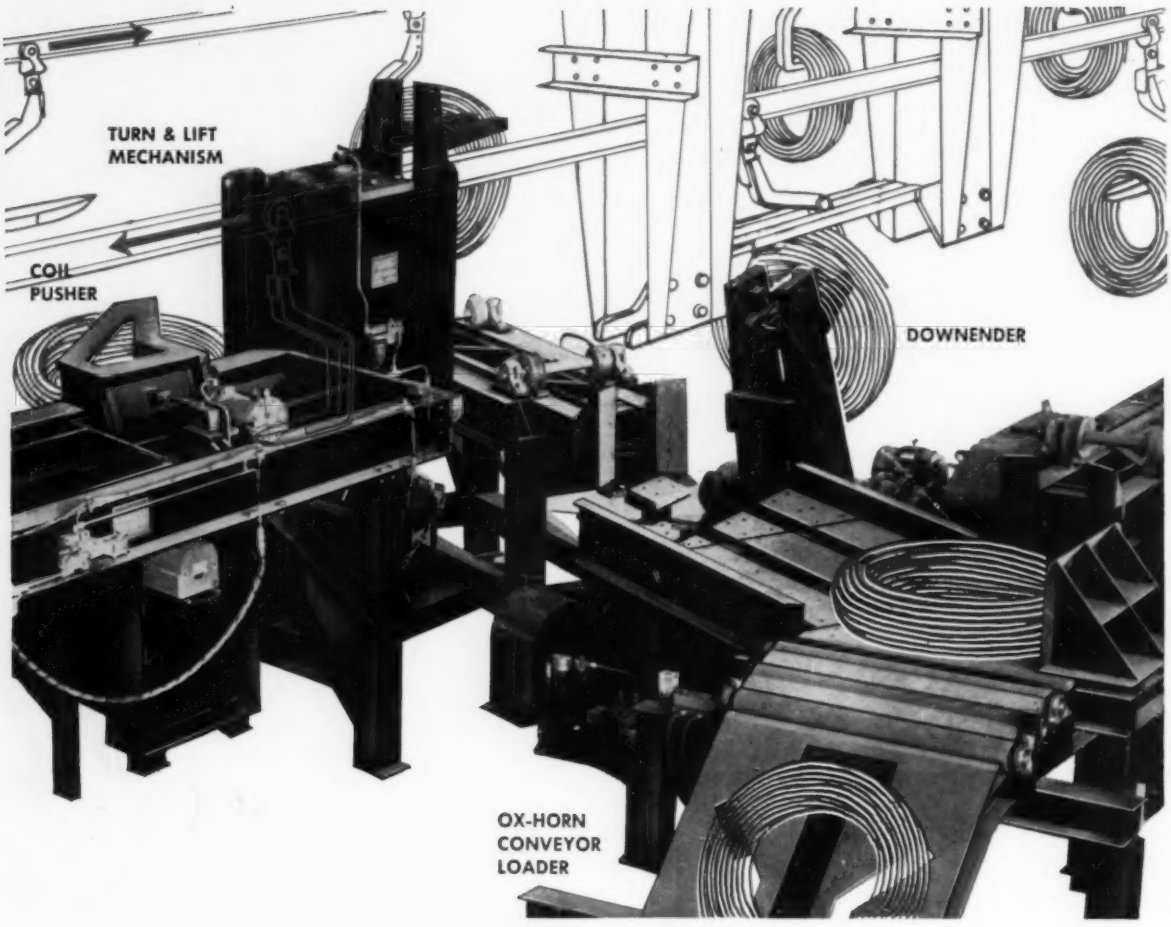

another example of Planet Versatility...

COIL HANDLING SYSTEM LOADS AND UNLOADS EXISTING CONVEYORS AUTOMATICALLY

This automatic coil handling system is an example of how *Planet Versatility* helped one of America's largest steel mills modernize its 10-inch bar mill to handle larger, 2000-pound bar coils . . . and save money by designing the coil handling equipment to load and unload *existing* conveyors.

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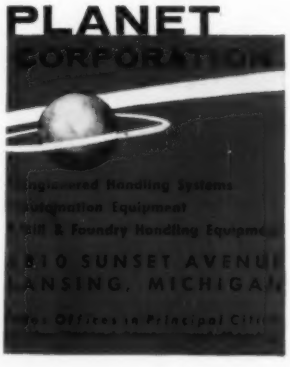
Write or phone to have a Planet engineer demonstration how "PV" can help you . . . you'll find *it pays to plan with Planet.*



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Second Operation

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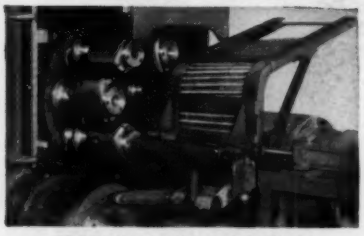

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DECEMBER 1959
Vol. 6 — No. 12

AUTOMATION®

A PENTON PUBLICATION

The Magazine of Automatic Manufacturing Operations

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automation outlook

PRESSWORKING PROGRESS

". . . progressive developments in pressworking have truly led to a better life for all. Higher rates of production and consistently higher utilization of press productive capacity have benefited the whole pressworking organization. Conditions of work and rates of pay have improved for the operators, and the shrinking of pressworking profits has been avoided or slowed. Finally, the general public has gained through the availability of greater quantities of press made products at lower prices than would otherwise be possible. Basic mark of the pressroom changes bringing this better life has been the integration of work performing, handling, and control functions in automated equipment installations. . ."—*Lee D. Miller, associate editor, see page* 40.

HARDWARE AVAILABLE

". . . the primary goal in warehousing does not differ in essence from the goal of other operations in industry—the operator or manager is interested in obtaining the most economical and efficient operation . . . equipment is available today to satisfy virtually any desired degree of automation, including means of completely integrating the paperwork phase (inventory control, bills of lading, invoices, etc.) with the movement of goods. . ."—*H. C. Keller, vice president, Lamson Corp., see page* 65.

PICK PAYING PROJECTS

". . . just as in product research, in manufacturing research it is necessary to pick the areas where this work has a high probability of paying off. Too often mechanization and automation are undertaken without a complete analysis of the economic framework. It is also true that too often mechanization is done on the basis of adapting hand tooling methods to a machine operation, without careful consideration of whether there are simpler and better ways. Thus, with the threat of foreign competition upon us, it is even more important that we fill this gap . . ."—*W. J. Pietenpol, vice president & general manager, Semiconductor Div., Sylvania Electric Products Inc.*

DEBUGGING DILEMMA

". . . we have spent a great deal of time and money on the study of our processes and manufacturing methods with the thought of reducing labor costs by automation . . . it has been our experience that it is difficult to accurately estimate the costs of building the first (and perhaps only) machine needed to achieve a certain result. This is due to the fact that the "debugging" costs, because of the unpredictable problems usually encountered, tend to equal or surpass the design and building costs. This has resulted in project costs which are too high with respect to savings achieved. This is particularly true in the electronics industry where costs must be recovered in the short period of one year or at the most two years. Also, it has been our experience that by the time the machines are built and debugged, hand methods have been improved to the point where the realizable savings are usually only about 50 per cent of the original estimates . . ."—*R. L. Wolff, vice president, engineering, Centralab Div., Globe Union Inc.*

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. . . Fluid Power news

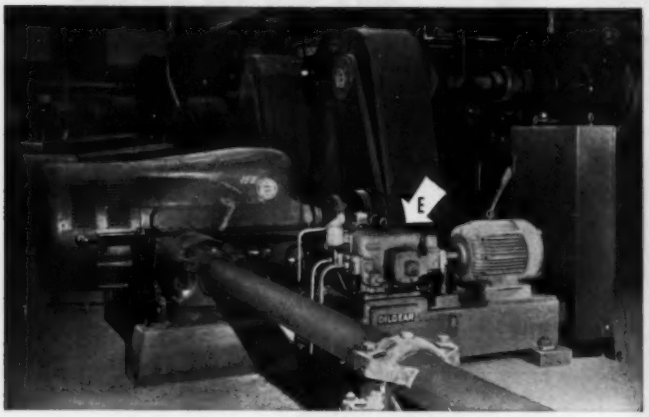
REPORT No. 12,104 OILGEAR SOLVES SPEED CONTROL PROBLEM

From Oilgear Application-Engineering Files

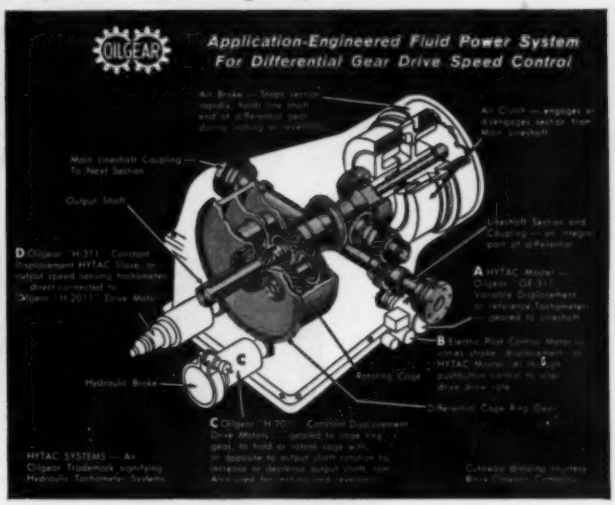
HOW HYTAC SYSTEMS CONTROL DIFFERENTIAL DRIVE SPEEDS ON NEW 190" PAPER MACHINE

USER: *Sonoco Products Company, Hartsville, South Carolina*
BUILDER: *The Black-Clawson Company, Inc., Paper Machine Division, Watertown, New York*

DATA: To design and build a differential-type drive, Black-Clawson engineers outlined the following over-all requirements: 1. To be rugged, simple, and have easily replaceable parts. 2. Speed variation device to control sizes from 150 to 1200 hp, and be capable of performing additional functions — inching, reversing, and slack take-up. 3. Device must maintain synchronous speed regardless of load or temperature changes. 4. Complete drive must be compact, clean design • After solution of gear mechanism problems, the following additional requirements were outlined for the speed variation system: 1. Simple, remote, section control panels, with all controls interlocked. 2. Draw range of at least ±4½%, precisely variable. 3. Must be capable of 24-hour continuous drive service with an absolute minimum of maintenance. 4. Would prefer one source, one responsibility for entire control system. (Mechanical, electrical, and hydraulic systems were investigated.)



A portion of Sonoco Products Company's new "Mr. Mac" — 190" (170" trim) Black-Clawson paper machine designed to produce 9-pt., semi-chemical corrugating board at speeds up to 1500 fpm. "Mr. Mac" is the first paper machine to be fully equipped with differential gear drives on which speed is hydraulically controlled and operated. Three of these new Oilgear Fluid Power Controlled, Black-Clawson differentials are shown above with one of the accompanying Oilgear "Power-Paks" clearly visible. These drives are used on the couch roll, first press, second press, first dryer section, breaker stack, second dryer section, calendar stack, and "autoflyte" reel . . . a total of 8 drives—5 rated at 150 hp, 3 rated at 300 hp.



SOLUTION: Application-Engineered *HYTAC SYSTEMS* arranged through teamwork between Oilgear and Black-Clawson engineers throughout the stages of design, testing, application, and actual installation.

Black-Clawson states — *"operating characteristics highly important to any papermaking machine are obtained through a unique hydraulic motor differential cage drive and a HYTAC SYSTEM (hydraulic tachometer feedback control arrangement). Significant features of this HYTAC drive are: 1. Machine sections can be inched or reversed with line shaft running or down. 2. No helper motors needed — no belts or chain drives involved. 3. Accurate speed regulation. 4. Precision draw control for all applications — 9% draw range. 5. HYTAC SYSTEM maintains speed regardless of load or temperature changes. 6. Hydraulic mechanism and control panels can be located remotely from drives. 7. Complete drive control interlocked. 8. Load on machine sections indicated by pressure gages on drive. 9. Compact, durable construction. 10. Absolute minimum of maintenance required."* The reasoning that led to selection of HYTAC SYSTEMS has also been clearly stated by Black-Clawson engineers, as follows: *"Mechanical drives had many serious drawbacks, such as horsepower limitations and the inability to perform the desired functions. Choice between electric or hydraulic drive proved more difficult . . . necessity that electronic controls circuits would be required to maintain accuracy, and the larger size of the driving units were the deciding factors in favor of the hydraulic drive. To determine size, an analysis was made . . . here again hydraulic drive proved its superiority, since the drive motor could be driven in both directions. Tests proved that the drive was even more accurate than our original expectations . . . regulation between zero and rated load was only ±0.005%. Under conditions of constant load and speed, a variation of ±0.002% could also occur . . . when added together, maximum regulation is ±0.007%."*

HOW IT WORKS: Fluid from lineshaft-driven master tach (A) gives differential drive speed command to control on Oilgear "DRX-2011" two-way, variable displacement pump (E), indicated in photo, left, of Oilgear "Power-Pak" installation. Slave tach (D) feeds back a flow signal proportional to actual differential drive speed. When main lineshaft speed increases or decreases, fluid flow from Master Tach (A) automatically increases or decreases correspondingly to command differential drive to follow lineshaft speed change. Through local or remote pushbutton stations connected to electric pilot motor (B) on Master Tach (A), operator can increase or decrease speed of each section infinitely up to 9% of prevailing lineshaft speed. When differential cage is rotated with, or in same direction as the output shaft by motors (C), output shaft speed is increased. If cage is rotated in the opposite direction by motors (C), output shaft speed is decreased. All factors, such as change in load or temperature, are automatically compensated by these HYTAC SYSTEMS to maintain exact, set degree of section synchronization with lineshaft at all times.

Accurate synchronization of multiple, tandem operations; combining separate operations to handle webs or sheets — soft, fragile at one point — strong at another; or continuous webs when tension affects quality . . . all need more than conventional drives and controls . . . they need the precision of HYTAC SYSTEMS, or other Oilgear "Any-Speed" drives and controls!

For practical solutions to YOUR linear or rotary Controlled-Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

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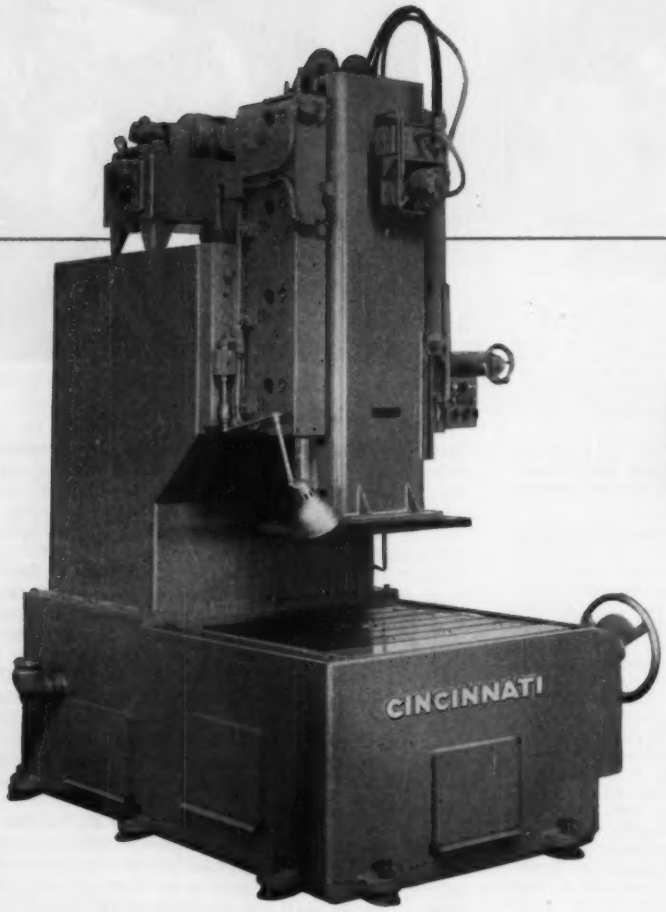
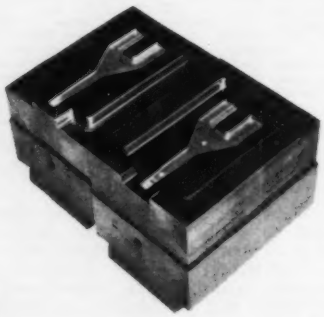
gives you a choice of 35 Electrical Discharge Machines





NO. 3 ELEKTROJET. This machine has the capacity for large heavy work, like the 15" long dies illustrated here.

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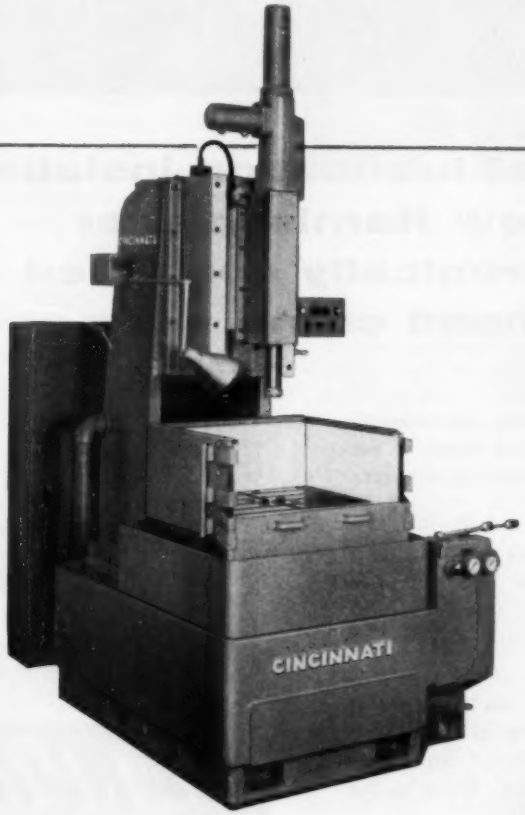
In the Elektrojet line there are 33 variations of the type illustrated below; plus two types for "grinding." They perform machining operations on a wide variety of parts ranging from small missile components to forging dies. Four styles of workheads are available: non-rotating, rotating, ram-type and universal. For all of them, a servo feed unit automatically maintains proper gap between electrode and work to assure maximum efficiency of metal removal. In addition, there are two styles of work tables, fixed or adjustable . . . four styles of dielectric tanks, solid, open front, disappearing or moving table . . . a selection of power supply units.

There are many other reasons why Elektrojet engineering and machines are the finest. Folder M-2077 contains the complete story. Write for a copy.



No. 1 ELEKTROJET with non-rotating workhead. Typical work is the extrusion die shown above, about 2⅞" outside diameter. Operation, EDM gear teeth through center.

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MILLING MACHINE DIVISION

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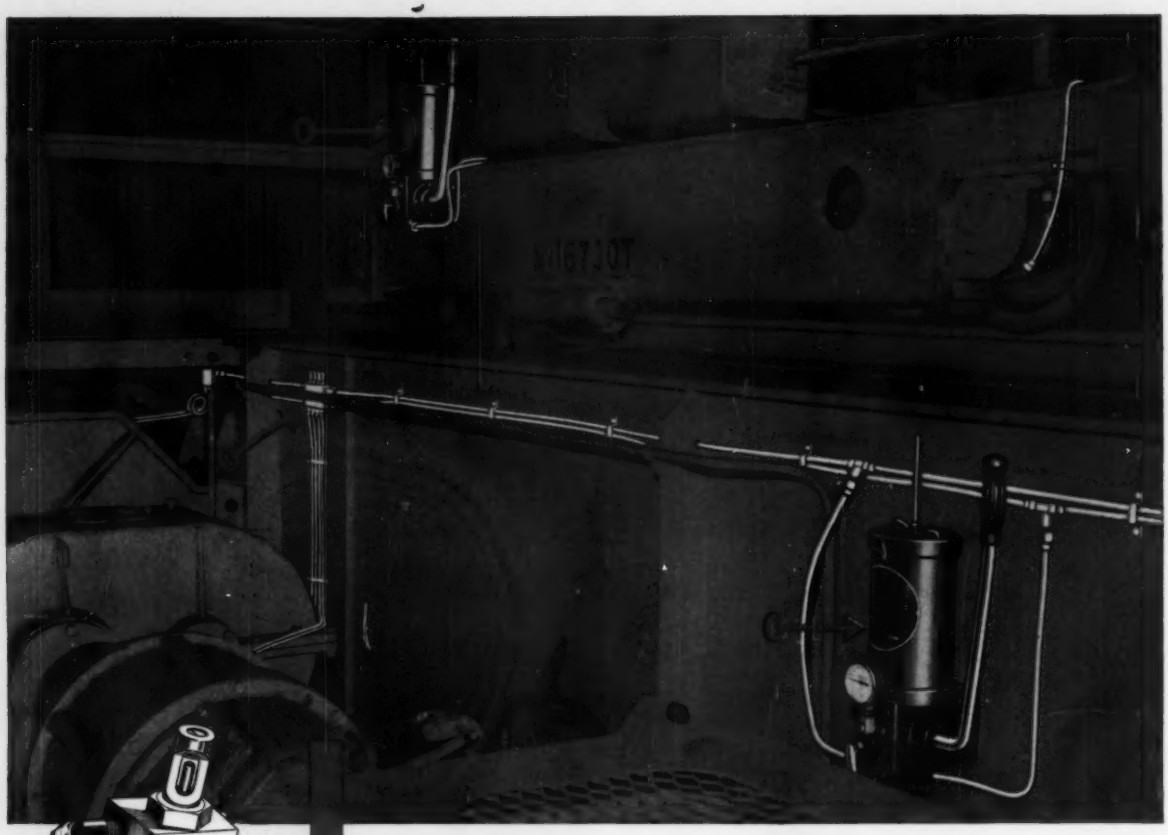

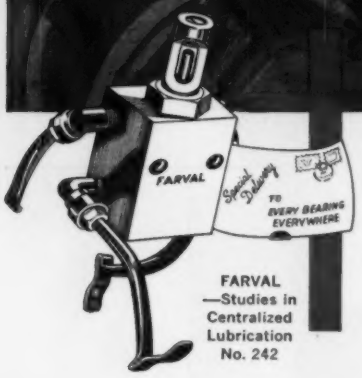

FARVAL
—Studies in Centralized Lubrication
No. 242

Farval lubrication installed on new Harnischfeger electronically controlled overhead crane

When Harnischfeger Corporation, Milwaukee recently demonstrated its new electronically controlled, heavy-duty overhead crane, it was equipped with a Farval centralized, full-protection lubrication system.

Why?

Because Harnischfeger engineers knew from past experience that a Farval centralized lubrication system can always be depended upon to provide the right amount of lubrication — when it's needed, where it's needed — for the rugged-going that giant overhead traveling cranes meet in their daily shop service.

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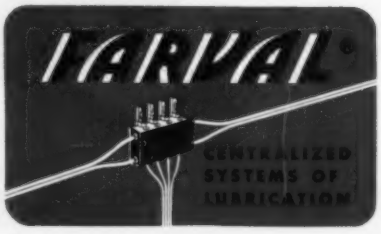

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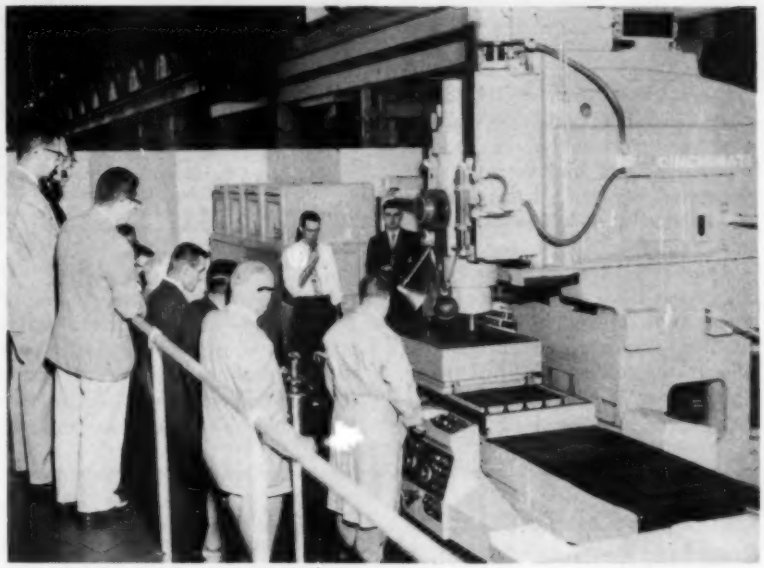
AUTOMATION news

Today's events and developments in the field of automation

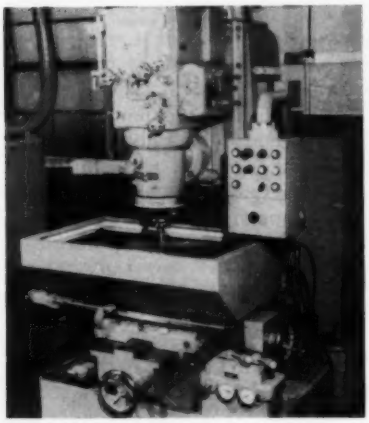
Machine Tool Builder Celebrates 75th Anniversary

MARKING its 75th year in business as a machine tool manufacturer, Cincinnati Milling Machine Co. recently held a three-week open house to demonstrate its contributions to technological developments in the machine tool field. During the anniversary celebration, the company unveiled more than 20 new machine tools designed to help industry cut costs and increase production.

Visitors to the open house were treated to a day-long tour of the Cincinnati installation. Called "Adventures In Progress," the tour employed closed circuit television, a 4-station indexing merry-go-round, moving pictures, a miniature sidewalk train, and a "political convention" inside a red and white striped plastic bubble tent to put across various points of the Cincinnati story. Throughout the day, the visitors saw 87 individual machine tool demonstrations.



OPEN HOUSE visitors at Cincinnati Milling Machine Co.'s 75th anniversary show watch a numerically controlled 30 x 52 inch vertical Hydrotel milling machine in operation. The day-long tour of the machine tool company's plants carried the visitors past 87 individual machine tool demonstrations.



TOUR guests saw one of the 33 electrical discharge machining tools in action. Metal is cut or eroded by an electrical spark. The only indication that work is being done is a wisp of smoke at the point where the electrode enters the oil bath.

In the numerical control exhibit, visitors saw a variety of machines being operated. These included a 30 x 52 inch vertical Hydrotel, performing a numerically controlled diesinking operation on a die for a milling machine cover; a 16 x 30 inch vertical Hydrotel, exhibiting the use of numerical control for machining three-dimensional right and left hand parts with a single program; a Heald Boramatic, precision machining a free form part at the direction of numerical control; a 24-inch sliding head drill with a new low cost 10 x 10 inch numerically controlled positioning table; a 20 x 48 inch two-axis type positioning machine with numerical control of position, feed, and speed; and a 48 x 168 inch traveling column Hydrotel, contouring an aircraft part by direction of numerical control.

In addition, during the political convention-type presentation, the company announced a new numerically controlled lathe. There are no manual controls on the lathe, and all functions are controlled either electronically or hydraulically from a program tape. Selection of feeds and speeds, selection of tool sequence, positioning of the tools, length and depth of cut are all punched into the tape and performed automatically. The lathe uses a six-position tool turret equipped with six basic turning tools. The only operator attention required is to load and unload the workpiece, insert the program tape in the tape reader, and start the automatic cycle.

Other highlights of the open house tour included:

- Introduction of a new fixed-knee milling machine which combines the rigidity of a bed-type, the convenience of a knee and column type,

and the capacity of a rise and fall type milling machine. The design eliminates the vertical movement of the knee and transfers vertical motion to the spindle carrier. The saddle and table are mounted directly on the machine bed. Rise and fall movement is transmitted vertically through a screw which also serves as a secondary point of suspension for the spindle carrier.

• A look at some of the company's 33 new Elektrojet electrical discharge machines. These machine tools are constructed on building block principles, and share between them the option of 2 bases, 2 slides, 4 workheads, 4 basetanks, and 4 power supplies.

• Demonstrations of metalworking machines that employ controlled force and controlled heat, rather than a cutting edge or grinding wheel, to produce finished work. Shown was a new Intraform machine over 200 feet long which is used to fabricate precision tubing of both ferrous and nonferrous materials, a hydrospinning machine that uses hydraulic pressure to power opposed rollers which shape-form a workpiece to the contour and size of a rotating mandrel, and a hydraforming machine which uses a male punch and a draw ring—contoured to fit around the punch—to deep draw shells from flat blanks. Also seen were flame heating machines.

LAST stop on the Cincinnati Milling Machine Co. tour was inside this air-supported bubble tent. Amid the hoop-a-la of a mock "political convention", three new machine tools were unveiled for the first time. Shown in the center is a new toolroom milling machine and at the right is a numerically controlled lathe. The third tool introduced was an automatic grinding machine for sharpening milling machine cutters.

Cracking Process To Use Open Loop Computer Control

MORE efficient operation of a natural gas liquids cracking furnace is expected through the use of a Recomp general purpose digital computer being installed at a Phillips Chemical Co. plant in Sweeny, Tex. The computer is a product of Autonetics, Div., North American Aviation Inc., and will be tied in with a Phillips developed data scanning and conversion system.

The new process control system will be on stream at the plant where natural gas liquids are converted to ethylene for later processing into polyethylene plastics and other chemicals. Though presently an open loop operating guide system, the system is expected to evolve into closed loop control. The computer will be connected to a 30-channel data scanner which will convert analog signals from sampling points in the cracking process into digital pulses. Temperature, pressure, and flow conditions will be sampled at regular cycles.

Data collected will be used to calculate furnace conditions and yields. This information will then be compared to desired calculated operating conditions and yields. Following this, the computer will calculate and print out new set point conditions which should enable the process to attain the target conditions. Later, these set points will be made automatically in a closed loop computer control.

Westinghouse Announces Plans For Centralized R&D Center

PLANS for the creation of a centralized research and development center in Pittsburgh, Pa., have been announced by Westinghouse Electric Corp. The center will bring together on a single site all the key personnel associated with the company's broad centralized program of basic and applied research.

The site of the new center is a 100-acre area now occupied by the Westinghouse research laboratories. In addition to these existing facilities, two new buildings will be constructed to increase the total floor space of the center to 712,000 sq ft. An estimated 1750 scientists, engineers, and supporting personnel will occupy the completed facilities by 1961.

Joining the personnel of the research laboratories in the new centralized center will be personnel from the company's materials laboratories, the new products laboratories, the manufacturing planning and controls laboratories, and the patent department. This combination of technical talent will provide the scientific disciplines requisite to the discovery of new facts and principles, furnish the know-how to find practical applications for new knowledge, convert ideas from laboratory experiments to useful products through modern manufacturing concepts, and provide the legal talent to protect new technical innovations developed.

Post Office Contracts For Automatic Address Reader

CONTRACT for the development of an advanced, more sophisticated address reader for the Post Office Dept. has been awarded to the Intelligent Machines Research sub-

Automatic marking of hot steel . . .

Controls by ALLEN-BRADLEY, of course

Here's an interesting job that's gone "push button"—stamping heat numbers on hot steel! Now, from a remote console, the operator automatically sets numbers on the marking head and propels it against the steel. The controls, *of course*, are Allen-Bradley because they provide the continuous reliability that is essential to this production.

The simple, ONE moving part solenoid design of A-B starters and relays assures millions of trouble free operations. And the double break, silver contacts—used on all A-B control—eliminate costly downtime for maintenance. Keep your production lines rolling . . . insist on Allen-Bradley *quality* motor control. You cannot do better!

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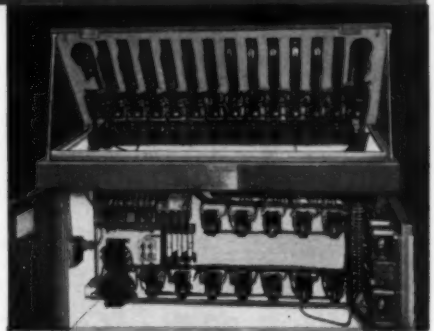


The relays and push buttons used in the remote control console of this M. E. Cunningham Marking Machine are all standard Allen-Bradley catalog items.

Circle 659 on Page 19

sidiary of Farrington Mfg. Co. The $114,000 contract calls for "advancing the development of electronic analyzing, automatic reading equipment, and for producing an engineering test model of a completely automatic letter sorting machine" as part of the Post Office's program to automate its operations.

The new address reader will be a transistorized prototype of an existing production model. It will be able to read and sort letters for 40 destinations while the earlier model was limited to 20 places. The 18-month contract calls for a machine that will sort at the minimum rate of 10,000 letters per hour. Although the current experimental model and the proposed advanced reader will read only printed or typed addresses, the Post Office contract calls for research into reading of hand-written addresses.

Instrument Programs, Controls, And Records Process Action

MULTIPURPOSE instrument that follows a pencil-drawn program on a strip or circular chart, initiates control signals from this data to regulate a process, and then indicates and records the process performance on the same chart has been developed by Research Inc.

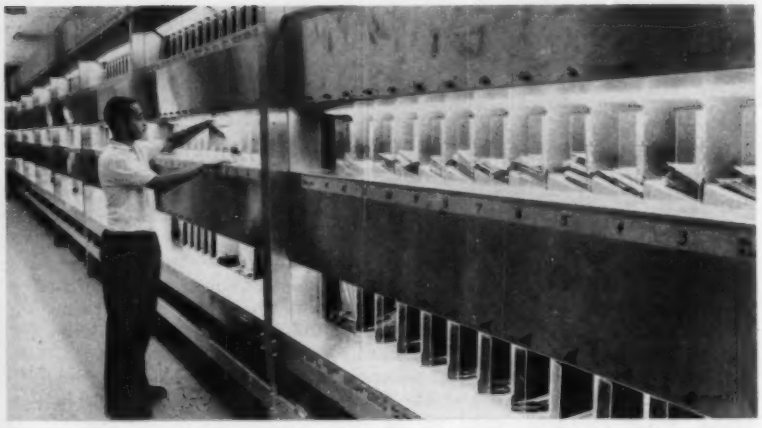
The new instrument is called a Prekorder and is available in either strip-chart or circular chart models. Process programming is accomplished by drawing two parallel pencil lines on the chart denoting the control path for the process. The spacing between the lines determines the degree of control exercised; that is, wide spacing reduces instrument sensitivity and narrow spacing increases sensitivity for close control.

The two parallel lines defining the process program are connected electrically to the two ends of a centertapped transformer winding which serves as a voltage source for

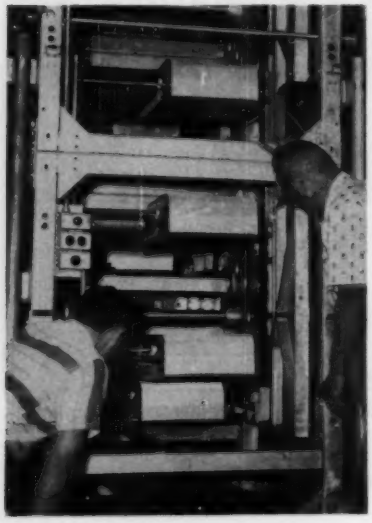
Keyboard Input Controls Letter Sorting Machine

LETTER SORTING machine built by Burroughs Corp. is capable of sorting 43,000 letters an hour to 279 destination bins. This machine is the first of 10 being built by Burroughs under a $1,869,000 research and development contract with the Post Office Dept. The system consists of 12 operator input stations with encoding keyboards, a letter distributing conveyor system, 279 decoding units at the destination bins, and a supervisor's control station. A feature of the system is that it is designed in modular units and is readily adaptable for use in post offices of varying sizes. For example, the Detroit post office will be equipped with 30 sorting machines, each having 12 operator input stations. Smaller post offices will start off with only one machine having from one to 12 keyboards. As the mail volume increases, additional keyboards can be added to the machine.

INTERMIXED letters of varying sizes are loaded into a hopper at each operator console. A vacuum-head arm automatically picks up each letter and positions it on an operator's scanning board. Operator reads letter address and enters destination code on a piano-type keyboard. Coded letter then moves to conveyor system behind wall.

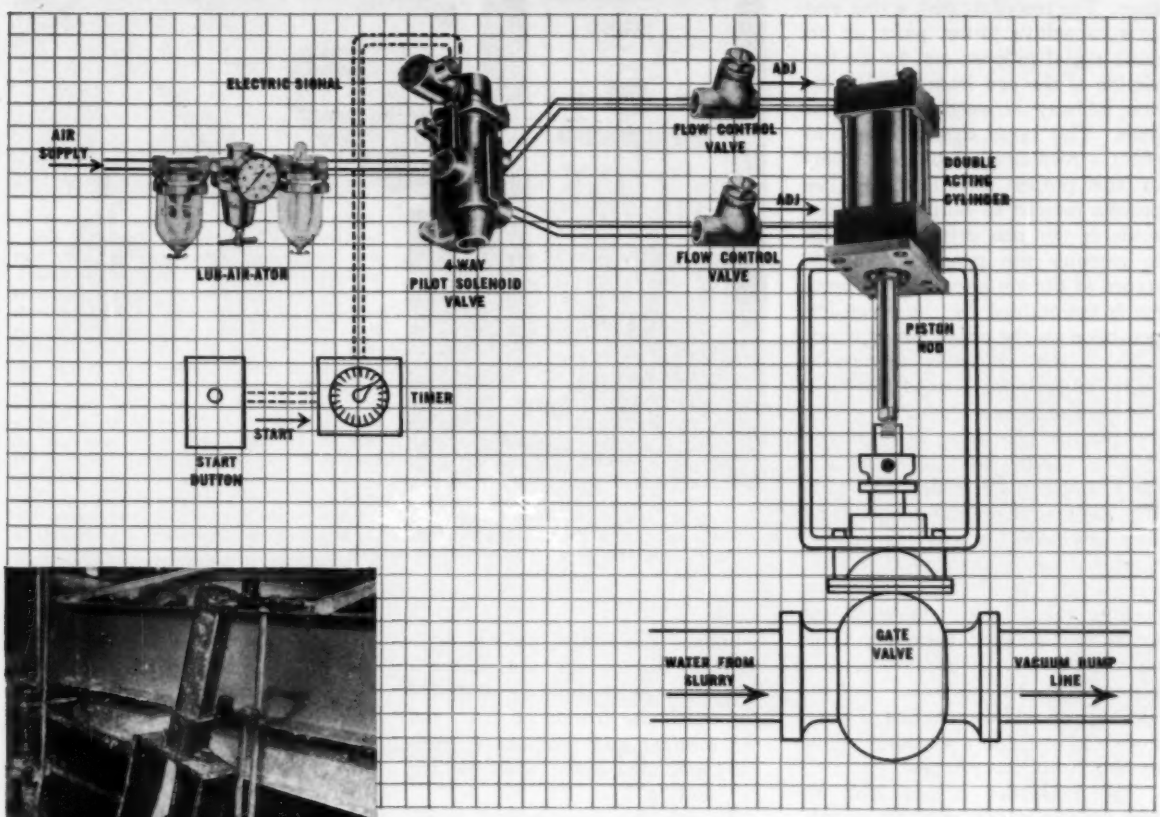


WHEN the letter cart reaches the proper destination bin, the nylon code wheels initiate action to release the letter from a compartment to the sort bin. The machine's sorting bins are arranged in tiers and are easily accessible from the front for emptying. An alarm system at a supervisor's control station signals when any of the bins are near capacity. Automatic counting devices register the number of letters being processed, and each letter is coded with a symbol identifying the operator control station where it entered the system. The sorting machine will handle letters ranging in size from 2¾ by 4 inches to 6 by 12 inches.



LETTERS are conveyed to proper destination bin in one of 161 letter carts. Each cart is divided into 12 compartments, and each compartment is assigned to one of the 12 operator consoles. Extending from each compartment is a shaft holding a series of nylon code wheels. When a letter is indexed into a compartment, an electromechanical signal from the keyboard arranges the code wheels into a pattern which designates the one of three tier levels and one of 279 destination bins.

PROCESSOR SPLITS PRODUCTION BOTTLENECK WIDE OPEN WITH HOOKUP OF STANDARD SCHRADER AIR PRODUCTS



Here's how one company automates with air. The hookup of Schrader Air Products in the large diagram actuates gate valves used in processing a slurry of raw asbestos fiber and cellulose at The Republic Seitz Filter Corporation, Newark, N. J. This used to be a slow, arduous manual job. Now air does it quickly, effortlessly, under "conditions particularly difficult for most kinds of automatic equipment . . . without a minute's downtime and without any maintenance whatever," says the company's Technical Director. Schrader-trained air specialists helped plan this practical set-up, as they have helped plan countless others.

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QUALITY AIR CONTROL PRODUCTS

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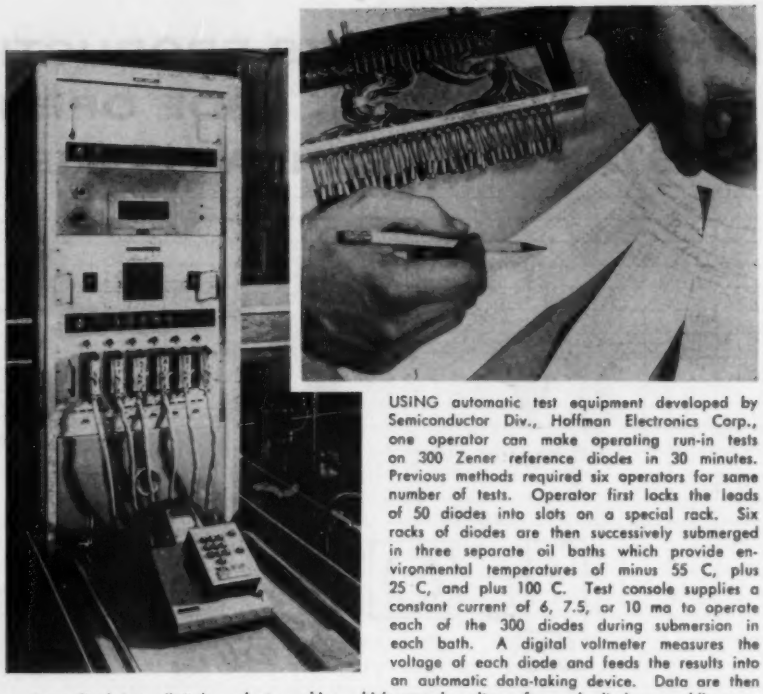
an electrostatic field between the lines. The recording pen, acting also as a capacitive probe, picks up an error signal proportional to the deviation of the pen from a null position midway between the program lines. This error signal is used to effect a readjustment of the process in the proper direction. As the process returns to normal, a sensor actuates the pen drive mechanism to recenter the pen. A complete record of the variations in the process is maintained by the recording pen trace on the programmed chart.

Since the recording pen-probe senses its position between the chart lines without ever touching them, the program chart may be overlayed by clear vellum paper on which the ink record can be made. This permits the master program chart to be used repeatedly as only the vellum overlay need be changed after each recording. Use of the overlay also permits introducing variable process limits by penciling boundary lines on the overlay. If the process deviates from its program, the recording pen will contact one of these lines and energize a warning signal or shutdown the process.

The Prekorder is adaptable to any process which may be electrically controlled and which can be monitored by a transducer, either mechanically or electrically connected to the recording pen. Typical examples are the programming and controlling of temperature, pressure, voltage, power, liquid level, humidity, flow, pH, position, speed, and force.



USING automatic test equipment developed by Semiconductor Div., Hoffman Electronics Corp., one operator can make operating run-in tests on 300 Zener reference diodes in 30 minutes. Previous methods required six operators for same number of tests. Operator first locks the leads of 50 diodes into slots on a special rack. Six racks of diodes are then successively submerged in three separate oil baths which provide environmental temperatures of minus 55 C, plus 25 C, and plus 100 C. Test console supplies a constant current of 6, 7.5, or 10 ma to operate each of the 300 diodes during submersion in each bath. A digital voltmeter measures the voltage of each diode and feeds the results into an automatic data-taking device. Data are then transmitted into digital readout machine which records voltage for each diode on adding machine tape. Each diode's voltage at the three environmental temperatures is compared for "drift", and units with excessive drift are rejected.

Logic Device Analyzes And Reads Cursive Writing

ELECTRICAL device which has the capability of identifying handwritten words has been developed by Bell Telephone Laboratories. Although the experimental device has a vocabulary of only ten words, the recognition principles used provide a basic step in a study of how more sophisticated machines can be made.

The device can identify the handwritten cursive script numbers from "zero" to "nine." It accomplishes this by means of a logic circuit which examines each word scribed on a writing surface for six features. These features include the length of the word, the dotting of "i's", and the number and position of vertically extended letters such as "h", "f", and "g".

To use the experimental handwriting reader, a writer moves a metal stylus over a special writing surface and forms the script number. Then, when an identify button is touched with the stylus, the written number is visually indicated in a listing on the board. The device has sufficient flexibility to recognize most individual styles of cursive writing. In a test of 1000 words written by 20 different people, the device correctly identified 970 words. The 3 per cent error can be eliminated by minor improvements.

The device was developed by **Leon D. Harmon** of Bell Telephone Laboratories. The special writing surface consists of 15 horizontal metal strips which are alternately sandwiched between strips of electrical insulating material. Movement of the wired metal stylus across the strips causes electrical connections to be made with the metal strips in sequence. The sequence and number of connections made are analyzed by a logic circuit consisting of 12 relays and 8 semiconductor diodes. A single recognition feature or a combination of features causes the proper relays to actuate and indicate the written number.

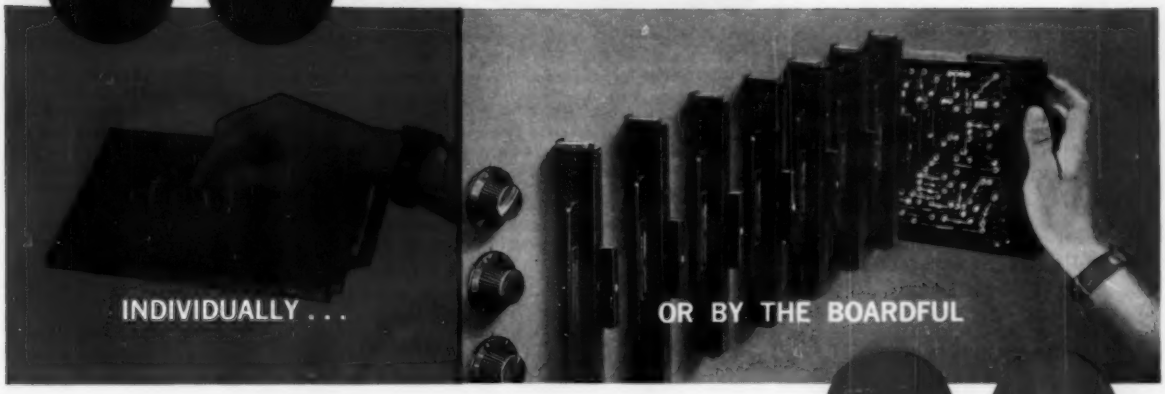
Forecasts Automatic Train Operation Without Crews

AUTOMATIC train operation, without the need for an operating crew, is possible and practical today from an engineering viewpoint according to **W. A. Robison**, design engineer of Union Switch & Signal, Div., Westinghouse Air Brake Co. Robison discussed the problem of crewless train operation at the annual meeting of the Signal Section, Association of American Railroads.

According to Robison, most of the equipment already being used in manual, semiautomatic, and automatic operations on railroads can also be applied to achieve fully automatic operation. In addition, the existing geographical patterns and physical layouts of railroad systems make them the only form of transportation which can make use of automated operation conveniently.

In an automatic traffic control

INSTANT



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A DIVISION OF GENERAL DYNAMICS

Circle 662 on Page 19

FORTY-EIGHT consoles, similar to the one shown, automatically program the cleaning of 94 rapid sand filters at Philadelphia's new $25-million Torresdale filtration plant. Engineered by the Brown Instruments Div., Minneapolis-Honeywell Regulator Co., the instrumentation system initiates a program that cleans a filter in 30 minutes as compared to 3 to 6 days using 15 to 20 men to clean a slow sand filter in the old treatment plant. Pretreated water is filtered through 10 inches of gravel topped by 28 inches of sand. Instruments on the console measure the rate of water flow through the filter and the loss of head. When this loss reaches a predetermined point, an audible alarm sounds, and a signal light informs an operator which filter requires cleaning. By pressing a pushbutton, the operator starts an automatic backwash operation which actuates valves, pumps, and mechanical devices to clean the filter.

system, "decision making devices" would be located along railroad rights-of-way to make decisions based on traffic situations. These devices would control train routing, starting, acceleration, deceleration, and stopping. Servo units mounted in the locomotives would control train movements as commanded by the decision making devices. Data would be fed to a central monitoring panel where a dispatcher would supervise over-all train movements. Any abnormal traffic problem beyond the handling capability of the decision making devices would be automatically referred to the dispatcher for manual handling.

Robison said that limited automation has already been successfully applied to some railroad operations. There are robot switching locomotives in freight classification yards which are remotely controlled. Consideration is being given to the remote control of helper engines as well as remote control of inplant switching movements.

Tests are now underway in New York for the small scale operation of a completely automatic train, according to Robison. Starting will be initiated by an automatic programmer, and the train will proceed to its destination and stop automatically. Automatic equipment will control its acceleration, its normal running speed, and a planned deceleration for stopping at a desired station.

Air Flow Factors Included In Revised Valve Catalog

DESIGNERS of pneumatic control systems are frequently faced with the problem of selecting valve sizes in critical applications where supply pressure, allowable pressure drop at the valve, and air flow rates are important considerations. These factors are particularly significant in cases where air cylinders must operate at high velocities and when circuit timing is critical.

As an aid to pneumatic system designers, Hannifin Co. has revised its valve selector catalog to include a minimum and a maximum capacity coefficient or flow factor for its complete line of air control valves. The coefficients have been calculated from laboratory measurements of actual air flow rates through production valves. The catalog also includes an engineering formula for use with the flow control data, a

around the triangle

A 30-TO-1 REDUCTION IN TESTING TIME

In order to reduce testing time of airborne servo systems from 90 minutes to less than 3 minutes, Douglas Aircraft Co. Inc. is procuring an RW-300 digital control computer from Thompson-Ramo-Wooldridge Products Co. The closed-loop control system will automatically calibrate the servo amplifier and networks; generate driving functions for the servo; measure the resulting servo system response; perform the necessary calculations; plot the resulting data; and monitor vibration, pressure, and temperature limits. The computer will also make possible more elaborate testing procedures which, in turn, will permit more parameters and limits to be checked and scanned than previously possible by manual techniques.

TRANSISTORS INCREASE USE OF VACUUM TUBES

There has been much speculation on how transistors will eventually replace vacuum tubes in all electronic equipment. A paradoxical development is that the use of transistors may actually increase the use of some types of vacuum tubes. For example, Amperex Electronic Corp. is increasing its facilities for the production of subminiature indicator tubes—a high vacuum triode with a fluorescent anode—due to the high demand for these tubes for use in transistorized computers. According to Frank Randall, president of Amperex, an average size transistorized computer may use as many as 2500 indicator tubes. Each tube identifies with a bright blue-green glow whether a transistor flip-flop circuit is in the *ON* or *OFF* position.

FAST COLOR CHANGE FOR PAINT DIPPING LINES

Looking for a method to reduce downtime when changing colors on an automatic paint dipping line? At a new plant of Cutler-Hammer Inc. in Lincoln, Ill., wheeled paint tanks can be moved on a track into operating position beneath a permanent conveyor dip when color changes are required. Only a 15-minute pause of the conveyor line is necessary to change from one color to another. In making a change, it is only necessary to disconnect dump line connections, and start an air-operated winch with a drum cable which pulls one dip tank out of painting position and spots the second. The tanks are 8 feet wide, 10 feet long, and hold 1000 gallons of paint. System was designed by Industrial Equipment Div., R. C. Mahon Co.

RADIOACTIVE ISOTOPES AT WORK

Nuclear and electronic automation devices are being employed by Goodyear Tire & Rubber Co. to maintain tire-building materials to a high degree of dimensional precision. For example, a nuclear instrument is used as a measuring device to maintain uniform thickness of the rubberized tire cord fabric as it is manufactured. Beta rays from strontium 90 pass through the material and are intercepted by an ionization chamber. Thickness of the finished rubber fabric sheeting is recorded by conversion of the beta rays to electrical signals. X-ray and fluoroscope machines also are in operation for spot checks of internal tire construction. A picture can be made for short-time study on re-usable photo-sensitive metal plates that hold an electrostatic image when exposed to radiation. Another device contains a radioactive source and detector which scans back and forth across rubberized tire cord and makes a continuous summary report on the performance of other nuclear and electronic controls on calendering machines.

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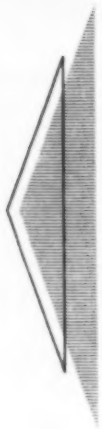
AUTOMATION

Information Service



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403	443	483	523	563	603	643	683	723	763	803
404	444	484	524	564	604	644	684	724	764	804
405	445	485	525	565	605	645	685	725	765	805
406	446	486	526	566	606	646	686	726	766	806
407	447	487	527	567	607	647	687	727	767	807
408	448	488	528	568	608	648	688	728	768	808
409	449	489	529	569	609	649	689	729	769	809
410	450	490	530	570	610	650	690	730	770	810
411	451	491	531	571	611	651	691	731	771	811
412	452	492	532	572	612	652	692	732	772	812
413	453	493	533	573	613	653	693	733	773	813
414	454	494	534	574	614	654	694	734	774	814
415	455	495	535	575	615	655	695	735	775	815
416	456	496	536	576	616	656	696	736	776	816
417	457	497	537	577	617	657	697	737	777	817
418	458	498	538	578	618	658	698	738	778	818
419	459	499	539	579	619	659	699	739	779	819
420	460	500	540	580	620	660	700	740	780	820
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422	462	502	542	582	622	662	702	742	782	822
423	463	503	543	583	623	663	703	743	783	823
424	464	504	544	584	624	664	704	744	784	824
425	465	505	545	585	625	665	705	745	785	825
426	466	506	546	586	626	666	706	746	786	826
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428	468	508	548	588	628	668	708	748	788	828
429	469	509	549	589	629	669	709	749	789	829
430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
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436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
439	479	519	559	599	639	679	719	769	799	839
440	480	520	560	600	640	680	720	760	800	840

AUTOMATION **December, 1959**

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BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.

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Beaver Precision Products INC.
CLAWSON, MICH.

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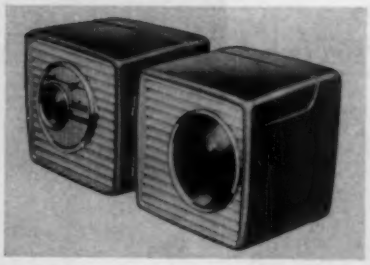


PHOTOELECTRIC control developed by Cramer Controls Corp. uses a modulated infrared sensing source instead of a visible light beam in order to eliminate random light interference. The projector on the left transmits a modulated infrared beam at a frequency of about 400 cps. The receiver on the right senses the infrared beam by means of a lead sulfide cell which generates an electrical signal. This signal is fed to a tuned electronic amplifier which is responsive to the frequency of the transmitted beam. If the signal does not carry the correct frequency, the amplifier ignores it. If the signal is correct, the amplifier energizes a relay which is used to control the attached load.

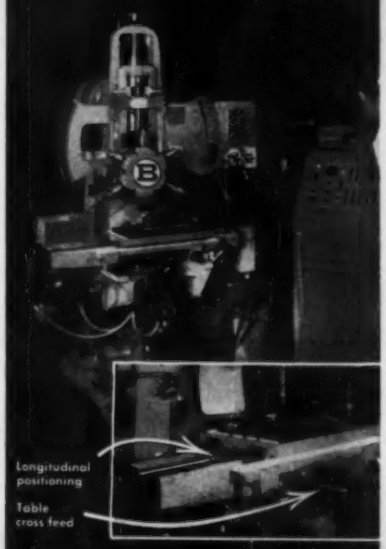
section explaining valve terms and principles, and other useful information to help in selecting an air valve which properly matches circuit requirements. Copies of the revised Hannifin Valve Finder are available from Hannifin Co., Dept. 142, 501 S. Wolf Road, Des Plaines, Ill.

SPOTLIGHTING PEOPLE

C. Robert Stone named chief production engineer at Potter & Brumfield, Div., American Machine & Foundry Co. . . . **William R. Swett** appointed director of manufacturing controls for International Business Machines Corp. . . . **Iden F. Richardson** named manager of Hughes Products Group, the commercial division of Hughes Aircraft Co. . . . **Edward J. Ferris Jr.** named factory manager and **Earl R. Lewis Jr.** appointed production manager at Pratt & Whitney Co. Inc. . . . **N. F. Parker** named operations manager of Computers and Data Systems and E. A. **Holmes III** appointed operations manager of Industrial Products, both at Autonetics, Div., North American Aviation Inc. . . . **S. S. Podnos** appointed general manager and **Sidney Weiser** named director of engineering for USI Robodyne, Div., U. S. Industries Inc. . . . **George E. Bartlett** appointed engineering manager of Moog Servocontrols Inc. . . . Ed-

AUTOMATIC
POSITIONING
TO ± .001"

RAPID
REPEATABILITY
TO ± .0005"



BURG
DOES IT WITH
'BEAVERS'

Burg Tool Mfg. Co., Gardena, Cal., uses Beaver Ball Screws for obtaining this exceptional precision in their low priced, tape controlled, turret drilling, tapping, boring "Burgmaster Electropoint" and offer with it simplified operation with minimum maintenance.

Most all important machine tool builders use Beaver Ball Screws, particularly in their tape controlled models. We offer complete engineering information and assistance.

Beaver Precision Products INC.
CLAWSON, MICH.

Circle 664 on Page 19

FOR QUALITY... PRODUCTIVITY ... PROFIT

MACHINING AUTOMATED BY GENERAL ELECTRIC

INCREASE MACHINE UTILIZATION

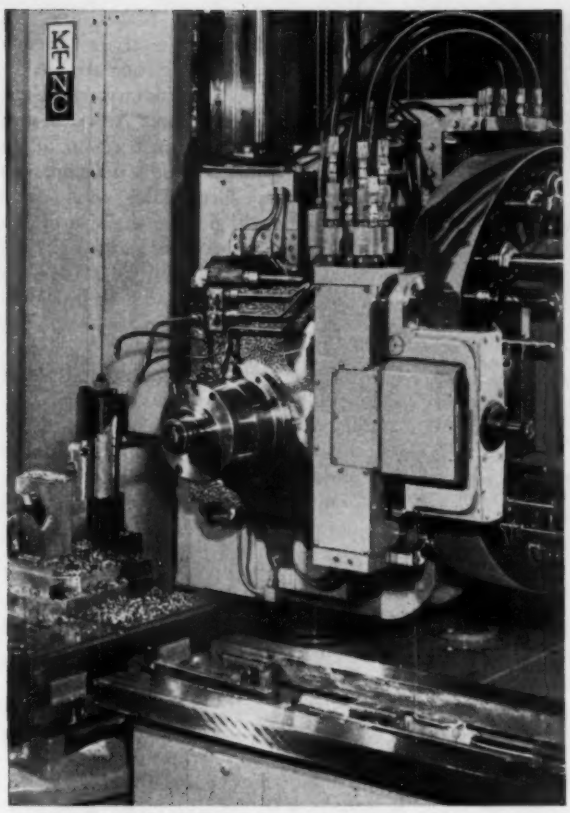
MARK SERIES NUMERICAL CONTROLS...

. . . . standard, job-proved packages now in use on a wide variety of machines

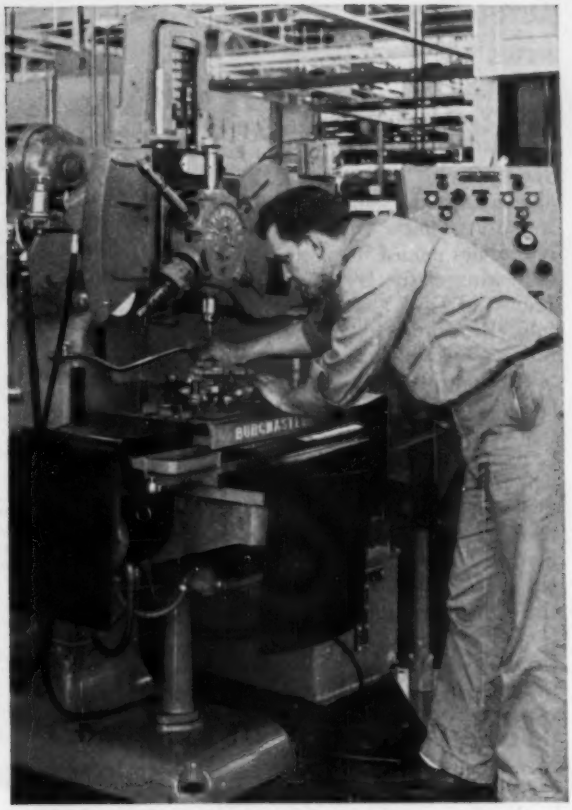
General Electric's Mark series of standard, pre-engineered numerical control packages—with systems for controlling 1 to 5 motions plus machine auxiliary functions — are compiling impressive performance records on scores of machines throughout American industry today.

Machine operation is completely automatic—from punched tape prepared on a standard automatic typewriter. If desired, semi-automatic positioning, useful for prototype work, is obtained with manually set dials on the control station.

Key components of a typical Mark package are a controller, a punched tape reader, operator's control station, servo drives and position-sensing units.



ONLY ONE SETUP NEEDED to produce even highly complex parts on this G-E controlled multi-purpose milling, boring and drilling machine means dramatic savings. And, tooling savings on one group of 6 parts totaled $10,000.



83% LEAD-TIME REDUCTION is average for parts produced on this 6-spindle turret drill directed by G-E numerical control. Tooling costs are 40% of former methods. Tape data-storage saves expensive tooling space.

with General Electric numerical control

Move quickly from part to part, cut non-productive machine time

An idle machine . . . and an investment going to waste! This is the case in plants throughout metalworking today—perhaps including yours!

Many reasons are apparent: tool-room lag in making fixtures; long setups during changeover; excessive manual positioning; or, poor machine scheduling due to manual operation. Whatever the case, this adds up to something you cannot afford: high unit costs.

But, there is a solution! General Electric numerical control on today's modern machines provides increased machine utilization that signals the end of long lead times . . . multiple setups . . . long machining cycles . . . and, excessive in-process inventories.

Reports prove the advantages of G-E numerical controls. One user states that with G-E controls, his milling, boring and drilling machine is making chips 55% more of the time . . . setup time is cut 40% . . . and positioning time is 50% less. All this—plus a major reduction in parts inventories made possible by G-E tape control's ability to exactly reproduce a part at any future time—enabled this user to pay for his numerically controlled machine in less than two years.

In another case, a new multi-purpose milling machine—directed by G-E numerical control—selects 31 different tools automatically. Non-productive machine-cycle time is virtually eliminated, and complete part machining is possible on a *single* setup. On one small-lot part, 749 hours were saved. Tooling savings on a group of 6 different parts totaled over $10,000.

Join with these and hundreds of users who are increasing machine utilization and worker productivity, and eliminating special tooling cost with G-E numerical control. See your G-E Apparatus Sales Engineer or machinery builder today. General Electric Co., Specialty Control Dept., Waynesboro, Va. 793-8

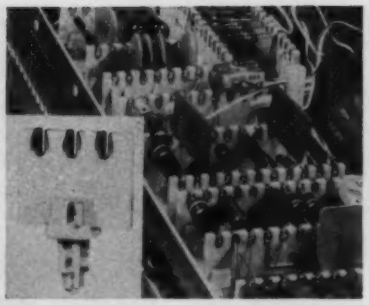
Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 665 on Page 19

AUTOMATION NEWS

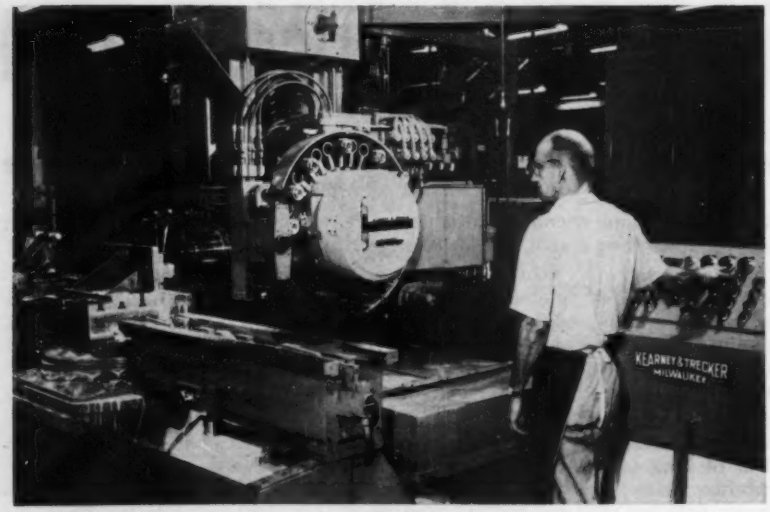
mond H. Judd named factory manager of Gibson Div., Associated Spring Corp. . . . **William K. Kindle** appointed chief engineer of Electronic Associates Inc. . . . **E. C. Nicholides** named manager of manufacturing of the Daystrom-Weston Industrial Div., Daystrom Inc. . . . **John R. Morton** appointed production engineering manager of Whittaker Controls Div., Telecomputing Corp. . . . **Dr. Paul M. Erlandson** named director of research of the Schlumberger Well Surveying Corp. . . . **J. R. Johnson** appointed executive vice president of Royal Industries Inc. . . . **Russell Meinke,** superintendent of facilities and layout for Aeronca Mfg. Corp., joined the Manufacturing Equipment Committee, Numerical Control Panel, of Aerospace Industries Association. . . . **John Jipp** appointed vice president of Ampex Corp. . . . **Dr. George C. Sponsler III** appointed a senior scientist at the Science Center, Hoffman Electronics Corp., to head a newly-formed systems study group. . . . **N. Bert Persson** named vice president of Food Service Engineering Corp. . . . **Dr. Joseph Kukel** named chief engineer of instruments and systems, Daystrom Pacific Div., Daystrom Inc.



QUICK assembly of ceramic terminal strips to equipment chassis is possible with new nylon yoke fittings developed by Tektronix Inc. The ceramic strips are made with one or two nylon yokes in place, depending upon the size of the strip. Polypropylene spacer sleeves are inserted in the chassis holes. A quick snap-fit of the nylon yoke-pins into the sleeves attaches the terminal strip firmly to the chassis. The connection will not break or release when subjected to shock or vibration. Three sleeve heights are available to vary the clearance of the strips over the chassis.

SPOTLIGHTING PLANTS

General Mills Inc. has acquired the business and assets of Magnaflux Corp., developer of techniques and equipment for nondestructive testing of materials. Magnaflux will continue in business at its Chicago location and will operate as a wholly-owned subsidiary of General Mills. . . . **Louis Allis Co.** has announced the construction of a new research and development center in Greendale, Wis. The building will double the size of the present engineering and physics laboratories and will be staffed by 100 engineers and technicians. . . . **Howe Sound Co.,** a New York concern with diversified manufacturing and mining interests, has acquired Sperry Products Inc. . . . **Fawick Corp.,** manufacturer of industrial and automotive clutches and brakes, has established a new Hydraulic-Electronic Div. to develop unique and highly original designs for special hydraulic and electronic units. The company entered the field of hydraulic components through the recent acquisition of New Products Corp. of Skokie, Ill. . . . **Consolidated Electrodynamics Corp.** and **Bell & Howell Co.** have approved in principle a proposal to merge the two companies. A detailed merger agreement will be developed and submitted to the directors and shareholders of both companies for approval. . . . **Ling-Altec Electronics Inc.** has announced plans for a $600,000 expansion to their plant in Anaheim, Calif. . . . **Benson-Lehner Corp.** and **Documentation Inc.** have announced plans to merge. The merger agreement calls for exchange of all Documentation Inc. stock for stock in Benson-Lehner and for the company to become a wholly-owned subsidiary of Benson-Lehner. . . . **Dumore Co.,** manufacturers of portable tools for milling, drilling, and grinding metals, plastic, and glass, has acquired Master Mfg. Co. Inc., machine tool manufacturers. . . . **H. K. Porter Co. Inc.** has acquired Peerless Electric Co. of Warren, Ohio, and has renamed it the Peerless Electric Div. of H. K. Porter Co. Inc.



PRODUCTION of small parts for the Boeing B-52G missile-launching system has been started on this Milwaukee-Matic numerically controlled milling, drilling, and boring machine. Installed at the Kansas Div., Boeing Airplane Co., the punched paper tape controlled machine tool is the first of five such units scheduled for this plant. B-52G parts such as elbows, housings, or forgings of the size and type which would roughly fit into an 18-inch cube can be handled on the machine. Two different parts are worked on alternately, and the unit automatically does any combination of drilling, tapping, reaming, surface milling, boring, or counterboring according to directions programmed on 8-channel tape. The machine was built by Kearney & Trecker Corp. and uses a General Electric Co. point-to-point positioning control system.

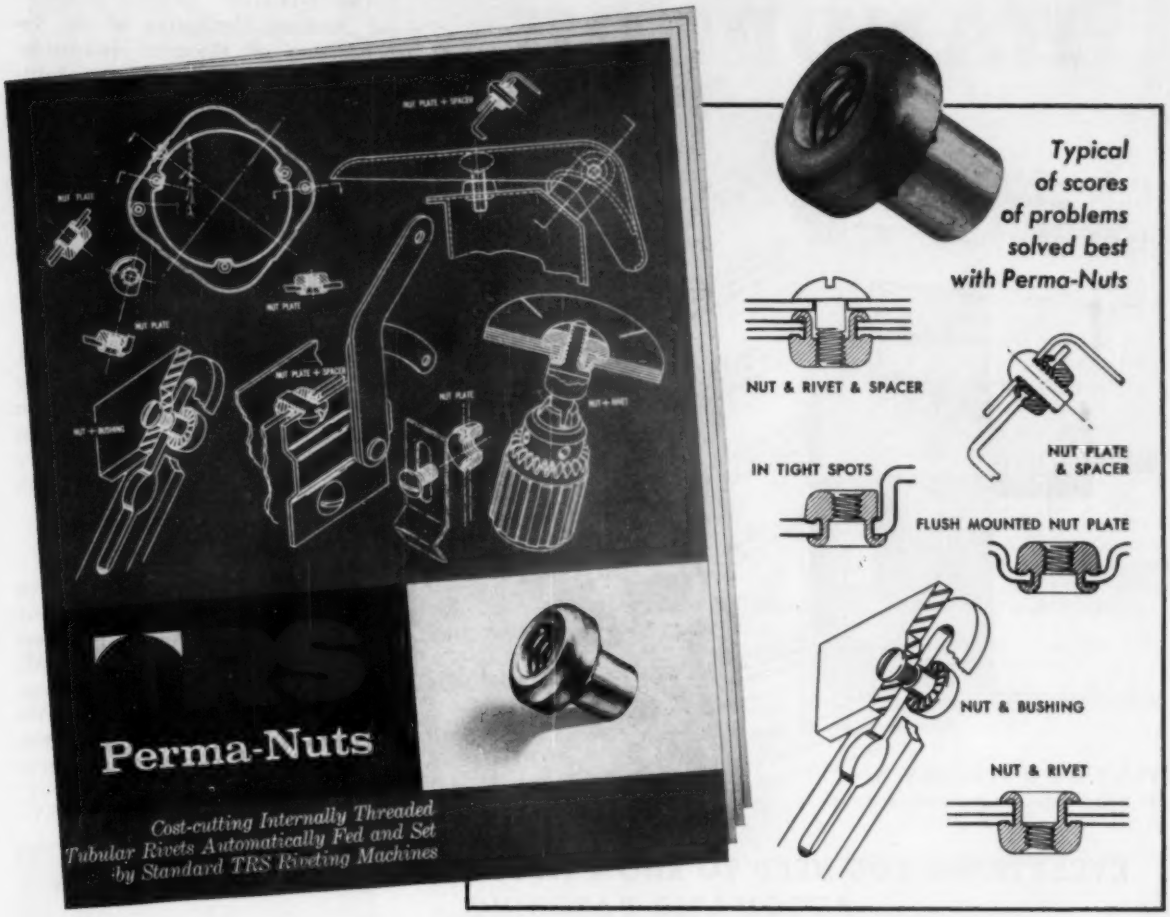
MEETINGS AND EVENTS

Dec. 6-10—

American Institute of Chemical Engineers. Annual meeting to be held at the Sheraton Palace Hotel,

Applied with standard TRS riveting machines

TRS PERMA-NUTS SAVE TWICE!


Perma-Nuts
Cost-cutting Internally Threaded Tubular Rivets Automatically Fed and Set by Standard TRS Riveting Machines
Typical of scores of problems solved best with Perma-Nuts
NUT & RIVET & SPACER
NUT PLATE & SPACER
IN TIGHT SPOTS
FLUSH MOUNTED NUT PLATE
NUT & BUSHING
NUT & RIVET

FREE CATALOG TELLS—

1 — *How and where to use them to simplify design and assembly problems*

2 — *How they are automatically fed and set by standard TRS riveting machines to cut production time & cost*

It will pay to keep versatile PERMA-NUTS in mind when you are specifying attachments and fastenings. Often you can use them to simplify design and reduce costs of an assembly . . . make it better, too.

They provide three to four strong threads to accept a machine screw, and allow direct design conversion from hexagonal nuts. Serrations under the head lock the Perma-Nut securely against turning . . . no need for a washer or key.

Remember, too, that this unique one-piece rivet and nut assures an extra economy . . . a *production* economy. No need for special equipment . . . no slow manual setting when you use Perma-Nuts. They can be automatically fed and set by standard TRS riveting machines.

Get acquainted with this dual cost-cutting device. SEND COUPON for new Perma-Nut Catalog.

TRS TUBULAR RIVET & STUD CO.
QUINCY 70, MASSACHUSETTS

Send Perma-Nut Catalog

Name & Title.....

Company.....

Address.....

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AUTOMATIC BATCHING HANDBOOK

EVERYTHING YOU NEED TO KNOW ABOUT AUTOMATIC BATCHING

- HOW TO DO IT
- HOW MUCH IT COSTS
- WHAT YOU NEED
- HOW TO USE WHAT YOU HAVE
- HOW TO SELECT THE RIGHT SYSTEM

If you are now combining two or more ingredients in any kind of formula or batch, write now for this new free automatic batching handbook. It describes in detail how automatic batching works, how to convert existing plant facilities or plan new plants for automatic operation. It illustrates the latest batching systems available, lets you select the right type for your particular needs. Also shows you how to combine materials handling equipment, storage facilities, and weighing equipment for greatest economy, increased production. This is the newest, most complete handbook on automatic batching available—be sure to write for your free copy today!

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San Francisco, Calif. Additional information is available from F. J. Van Antwerpen, AICE headquarters, 25 W. 45th St., New York 36, N. Y.

Dec. 7-11—

National Conference on the Application of Electrical Insulation. Sponsored by the American Institute of Electrical Engineers and the National Electrical Manufacturers Association, meeting will be held at the Sheraton-Park Hotel, Washington, D. C. Additional information is available from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Dec. 13-16—

Material Handling Institute Inc. Annual meeting to be held at the Savoy-Hilton Hotel, New York. For additional information, contact John M. Neeson, Hanson & Shea Inc., One Gateway Center, Pittsburgh 22, Pa.

Jan. 11-13—

Sixth National Symposium on Reliability and Quality Control. Sponsored by the American Society for Quality Control, AIEE, IRE, and Electronic Industries Association, meeting will be held at the Statler-Hilton Hotel, Washington, D. C. Additional information is

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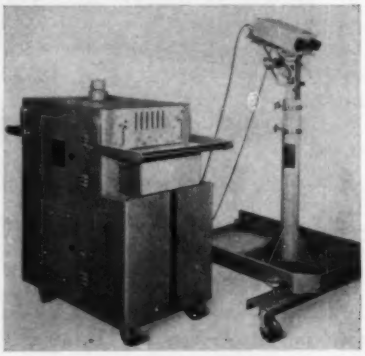


INFRA-RED equipment developed by Lindly & Co. is being used by American Steel & Wire Div., U.S. Steel Corp., to check the speed of red hot steel rod in a rolling operation. The double infra-red sensitive photoelectric device first measures the length of time it takes the leading or trailing end of a length of heated steel rod to pass two points which are a known distance apart. An associated electronic control then translates this data into a speed measurement. The portable equipment consists of a detecting head and a rolling cabinet containing the electronic control system.

NINETY-TWO drilling, reaming, and tapping operations are performed on jet engine diffusers with this special machine built by National Automatic Tool Co. Inc. for the Aircraft Engine Div., Ford Motor Co. The machine incorporates nine units deployed around an 18-position index table, 48 inches in diameter. Six of the units are multiple spindle drill heads, and three units are special traversing tapping units with automatic time delay, reverse, and positive stop. Several of the units include an auxiliary head arranged for 2-position indexing. The special machine is built with standard building block components (using riser blocks to set units at proper angles) so that future changes can be made at minimum cost and downtime.

available from IRE headquarters, 1 E. 79th St., New York 21, N. Y.

Jan. 25-28—

Institute of the Aeronautical Sciences. Annual meeting to be held at Hotel Astor, New York. Further information is available from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Jan. 25-28—

Plant Maintenance and Engineering Conference and Show. Eleventh annual conference and show to be held at Convention Hall, Philadelphia. Additional information is available from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Feb. 1-5—

Instrument Society of America. Regional ISA Instrument-Automation Conference and Exhibit to be held at Houston Coliseum, Houston, Tex. For further information, contact William H. Kushnick, ISA headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

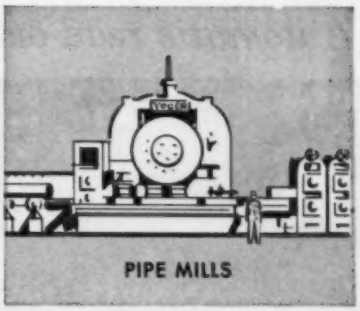
Feb. 2-4—

Society of the Plastics Industry Inc. Fifteenth Reinforced Plastics Division Conference to be held at the Edgewater Beach Hotel, Chicago. Further information is available from SPI headquarters, 250 Park Ave., New York 17, N. Y.

Feb. 3-4—

Midwest Welding Conference. Sponsored by the Armour Research Foundation and the Chicago section of the American Welding Society, meeting will be held at Illinois Institute of Technology, Chicago. Additional information is available from Harry Schwartzbart, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

"My word, professor! It describes a punched papyrus scroll device for controlling a potter's wheel!"



YODER PIPE AND TUBE MILLS

Today's expanding markets and tightening economy demand closer production cost control. YODER'S complete line of ferrous or non-ferrous Pipe and Tube mills can help you meet production schedules economically... help you realize significant savings in the manufacture of tube and pipe.

YODER Pipe and Tube mills offer flexible production to meet fluctuating demand. They adapt easily to the most rigorous schedules. Everyday manufacture of constant high quality pipe and tube in diameter of 5/16" to 24". Speeds up to 350 fpm plus can be obtained with YODER mills.

YODER also makes a complete line of Slitting equipment and Cold Roll-Forming machinery. Send for your copy of the fully-descriptive book covering Tube Mill operation.

THE YODER COMPANY
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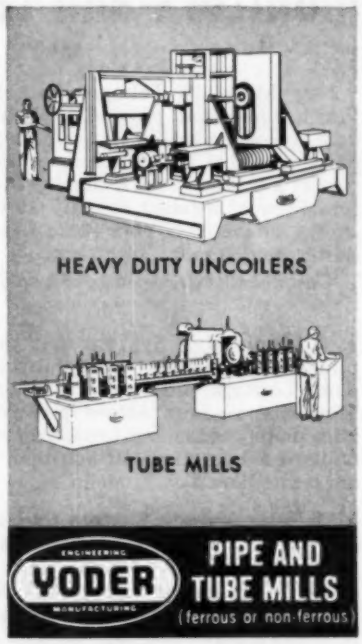

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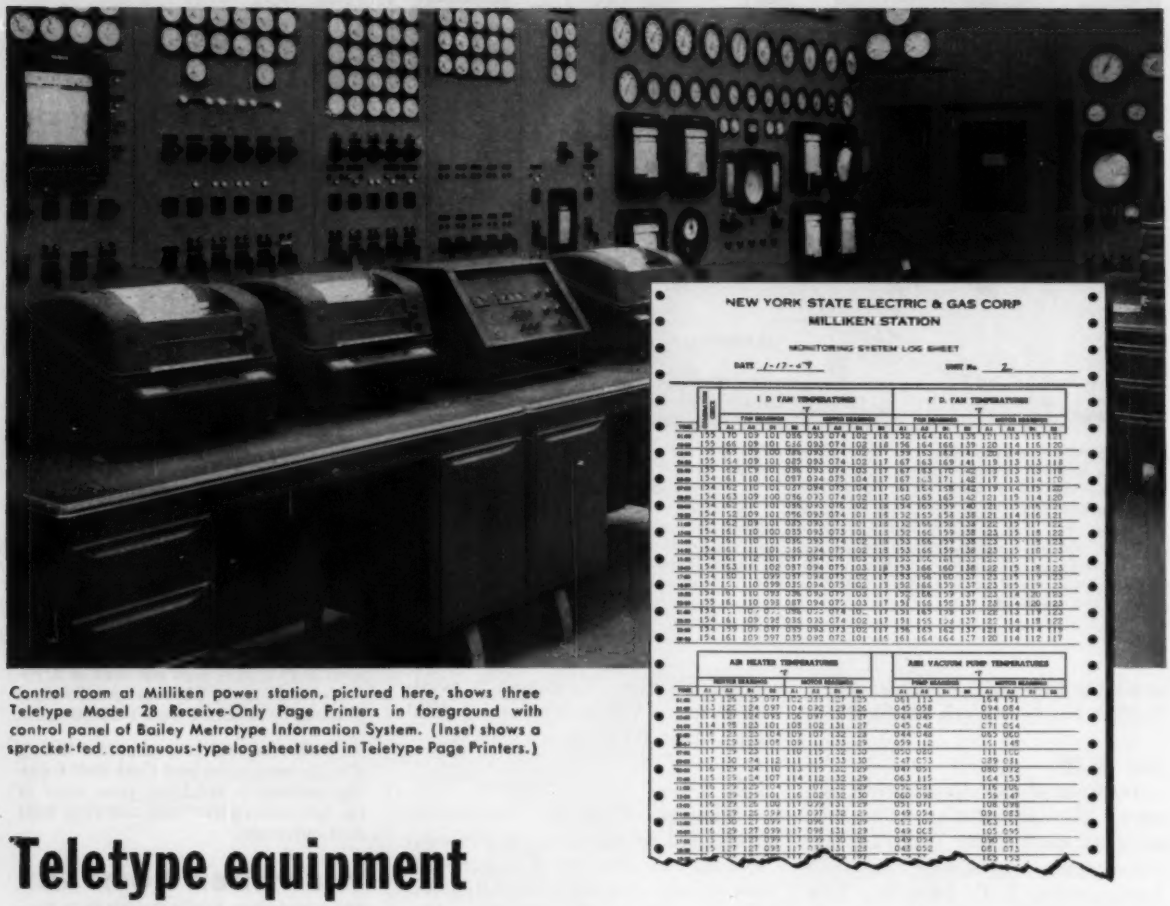
Automatic read-out . . .



Control room at Milliken power station, pictured here, shows three Teletype Model 28 Receive-Only Page Printers in foreground with control panel of Bailey Metrotype Information System. (Inset shows a sprocket-fed, continuous-type log sheet used in Teletype Page Printers.)

Teletype equipment monitors and records power station performance

New Model 28 Teletype Page Printers and Tape Punch equipment provide a continuous, dependable data processing facility for evaluating power station performance. This Teletype communication equipment is part of a Bailey Meter Company Metrotype® Information System installed recently at the Milliken power station of the New York State Electric & Gas Corporation, near Ithaca, New York.

This installation consists of two data systems:

1. A Monitoring System that continuously scans a total of 282 variables—temperatures of fan, motor and pump bearings; pressures of water and oil pumps, etc. Whenever readings exceed prescribed limits, system immediately reads and prints complete digital data of off-normal operation. In addition, complete readings are printed hourly.

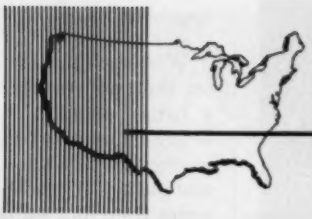
2. A Performance System that scans 66 points once every hour, measures generator output, main steam flow, feedwater flow, temperatures, etc. All factors required to evaluate the station's performance are logged on the Teletype Printers. A Teletype Tape Punch also produces a perforated tape for IDP.

Robert Darke, Systems Division Manager, Bailey Meter, says, "Teletype equipment was chosen for this installation because of its flexibility and proven reliability. Design is simple and trouble-free, and the units are manufactured specifically for round-the-clock rather than intermittent service."

Teletype equipment will handle data for virtually any purpose in any industry. Signals may be serial or multi-wire. Signal medium may be local electrical circuit, telegraph or telephone circuit, or radio.

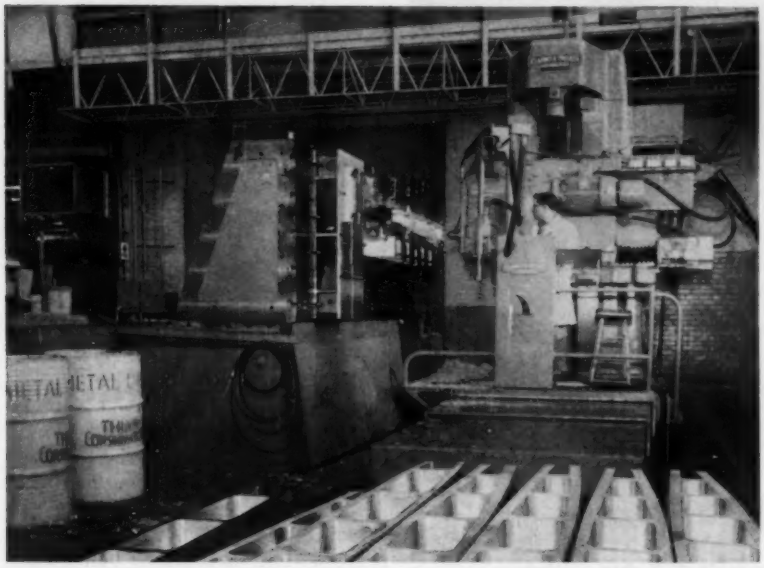
Why not find out how Teletype equipment can fit into your systems plan? Please write: Teletype Corporation, Dept. 21-M, 4100 Fullerton Ave., Chicago 39, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.



western trends

BY PATT PATTERSON
Los Angeles, Calif.



AUTOMATIC 54-ton profiler makes complex, close-tolerance cuts on wing root attach fitting for Northrop Corp.'s Norair SM-62 Snark intercontinental missile. The profiler is in use at Northrop's Hawthorne, Calif., plant as part of the U. S. Air Force's long range plan to insure strategic aircraft and missile building potential. The machine, manufactured by Kearney and Trecker Corp., is numerically controlled.

In Search of Savings

HISTORICALLY, the aircraft industry has not been as vulnerable to steel strikes as other large segments of this country's manufacturing potential. With the advent of missiles, however, the picture has changed: Stainless steel has become a prime consideration in airframe construction. Where industry officials once felt that there was little likelihood of a steel strike crippling the aircraft industry, a number are now sounding warnings about the affects of long steel strikes on the nation's missile program. This vulnerability to steel strikes increases with the growing emphasis on missiles.

There is talk of a drastic change in spending by the services in the next budget. While the value of aircraft orders in dollars is now almost double the value of missile contracts, the promise is that next fiscal year's apportionment by the military will be almost identical for both aircraft and missile programs. The new budget is rumored to cut aircraft purchases to the bone.

Heading the rumors, manufacturers are moving ahead with their plans for increased automation. By concentrating their production potential in automatic machinery, generally with numerical control, a great deal of work formerly farmed out by the primes to subcontractors will now be handled "in the house." Just recently, North American Aircraft attempted to change arrangements for building the B-70 by requesting that all work formerly planned for subcontract be brought into North American's own manufacturing facilities.

At Northrop, now producing the SM-62 Snark intercontinental guided missile, the T-38 supersonic trainer, and the NATO all-purpose fighter, great emphasis has been placed on numerical control. A good example of the advantages which have been realized by this one company is given in an analysis made of their operation.

During World War II, and in the immediate post war period, the average division of labor effort was 20 per cent for fabrication and 80 per cent for assembly. This was primarily due to the large amount of hand forming and adjusting during assembly. Today, in the same plant, labor effort divides up to approximately 50 per cent for fabrication and 50 per cent for assembly, and the picture is still changing. This is in spite of the fact that fabrication times have been speeded up with automatic equipment.

The increasing complexity of the parts used in building a supersonic aircraft or missile require precision fabrication, increasing labor time in that area, and yet permit quicker and less complex assembly. The size, weight, and intricate configuration of today's parts place increasing emphasis on tooling and machinery. Once made accurately, the parts have to fit.

Three Kearney & Trecker profilers now in use by Northrop are typical of the direction taken by the industry in general. The tools are a part of the U. S. Air Force's long-range plan to obtain advanced weapons systems economically, and this underwriting by the military has permitted the installation of capital equipment that the industry itself could not have acquired at such a rapid rate.

One part, now produced on the K&T profilers, formerly required five to six hours of machining time, using conventional techniques. The profilers turn out the same piece, to even closer tolerances, in 22 minutes. With time improvements of this magnitude more work flows and the costs drop.

with **LIPE**
Automatic Machine Loading

● You can meet and beat competition by getting peak production from every machine in your shop — new *and* old. Lipe Automatic Machine Loading delivers at least 90% of the gross geared capacity of any production machine, because stock is fed continuously. Your machines cut stock — not air!

● Lipe AML Bar Feeds automatically feed stock of practically every length, shape and material, in close-tolerance feedouts. Users report production increases of 40% . . . 90% . . . and even 200% per machine, plus labor benefits that are even more important. Workers are freed from back-breaking hand-loading of stock . . . concentrate on quality and machine set-ups. For a free estimate of what Lipe AML can do for your shop, send prints or samples of typical work. Write for full information.

Stop Cutting Air and You Start Cutting Costs

Lipe-ROLLWAY CORPORATION
SYRACUSE 1, N.Y.

PIONEERS IN PNEUMATIC BAR-FEEDING

Improved Brazing

With each passing month, a process that was thought to be strictly a hand operation is announced in a new, automated form. And automation usually does the job better and faster. In some cases, the advance from manual operation to automatic takes place through intermediate stages where manual dexterity becomes less vital, but human control must be maintained over every detail.

Brazing is an excellent example. Early brazing in the aircraft industry was performed on a piece-by-piece basis.

At Solar Aircraft Co.'s San Diego plant an automatic operation has been developed. The installation is a triple elevator setup utilizing gas atmosphere high temperature brazing on a production basis.

The new installation was designed by Pacific Scientific Co. to use three types of gases: Hydrogen, nitrogen, and argon. Every stage of furnace brazing is completely controlled. Gas selection and flow rates are selected on a master panel. Here too is the single pushbutton control for all electrically operated instruments and controls.

The installation is controlled throughout loading, purging, brazing, and cooling cycles. The oxygen concentration in retort and furnace atmospheres is indicated automatically, as well as furnace gas makeup by specific gravity. Gas pressure and flow rates are controlled, and automatic controls and warning signals are tied into the system to keep the operator notified of abnormal conditions.

Because of the necessity for human judgment in the correction of such conditions, the control loop is interrupted to permit the operator to exercise discretion in the correction process.

During retort operation, gases are continuously analyzed. The retort is first purged with inert gas. When instruments sense that the atmosphere is suitable for introduction of hydrogen, the gases are automatically switched. The control panel monitors the process continuously, indicating whether hydrogen is in the safe range, and notifying the operator when the retort is suitable for brazing.

Circle 670 on Page 19

MANY construction, design and engineering advantages contribute to the power-loaded thrusts of this heavy-duty O-M component. It is ruggedly constructed —all steel and bearing bronze. It is designed right to seal right against power loss. The large ports conduct an unrestricted flow of fluid to the piston, assuring full power. Cushion ball check valve provides for full power starts of return strokes.

The tensile steel, chrome-plated, standard or oversize, piston rods have a high yield point for higher load capacity. And the rod gland cartridge, threaded for easy removal, is piloted in rod head to assure perfect alignment undisturbed by heavy load stresses. In most installations, cartridge can be removed without removing mounts or tie-rod nuts. A complete selection of mounts is available.

Detailed information about these and other advancements is contained in our latest Bulletin No. 105. Mail coupon below *TODAY* for your copy or consult your local O-M representative.

ORTMAN-MILLER MACHINE COMPANY
2514 3rd Street, Hammond, Indiana

☐ Have representative call
☐ Send Bulletin 105

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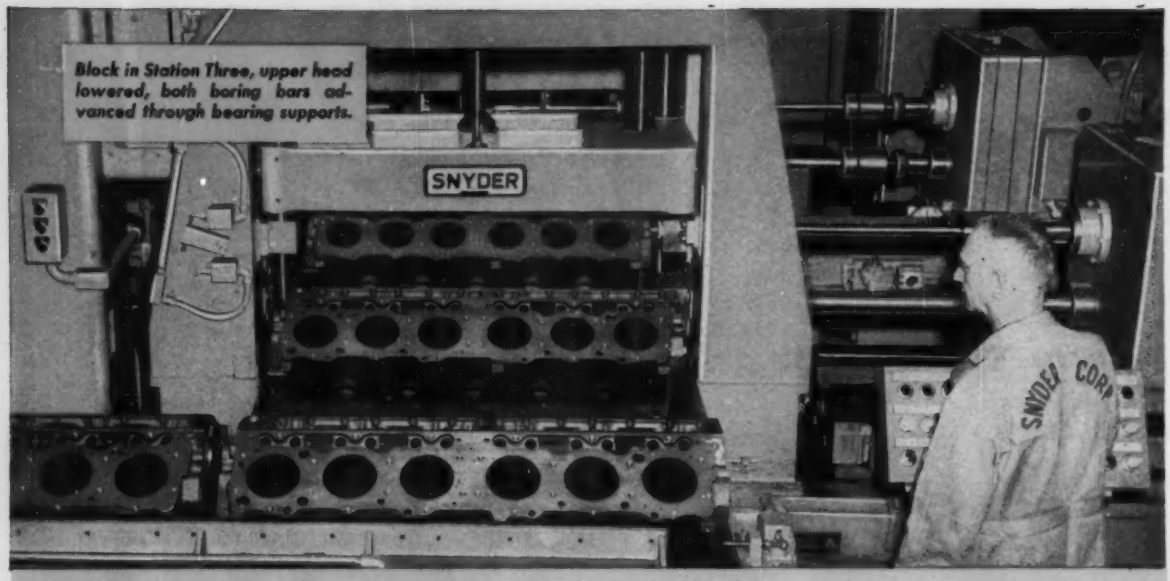
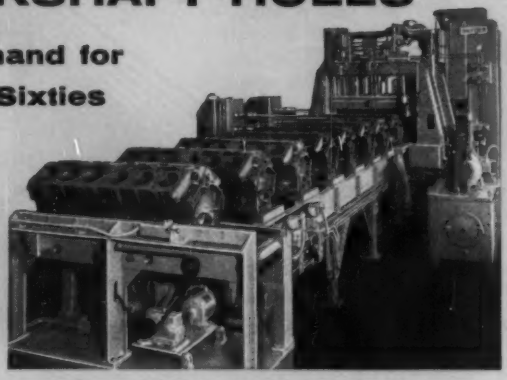
Circle 671 on Page 19



Block in Station Three, upper head lowered, both boring bars advanced through bearing supports.

PRECISION BORING OF 42″ LENGTH CAM AND CRANKSHAFT HOLES

SNYDERIZING Meets the Demand for Quality Parts for the Soaring Sixties



This 12-cylinder block is for heavy duty truck and marine engines aimed at taking a bigger bite of this booming market. Our Snyder special 7-station machine is helping this manufacturer SNYDERIZE for the Soaring Sixties by providing boring tolerances which make his product outstanding.

In regular production at a rate of 31 pieces per hour, main and camshaft bearing holes are rough and semi-finish bored simultaneously with all diameters held to manufacturers' specifications for alignment, roundness and concentricity. The distributor hole is also semi-finish bored in this machine to establish proper location to cam and crank bores.

Advanced engineering, both in product and production machines, is the best possible preparation for the competition of the next decade. We'll be happy to show you, too, how to SNYDERIZE for the Soaring Sixties to gain more efficient parts handling, gaging, assembly and machining. Write or phone for new brochure on machines for profit improvement.

Standard Features of Snyder Machines

1. SNYDER UNITS equipped with hardened and ground steel ways.
2. Building block principle throughout.
3. Automatic lubrication.
4. Walking beam transfer bar.
5. J.I.C. Standards throughout.
6. Electrical interlocks and full depth circuit throughout.
7. Panels equipped with SNYDER CIRCUIT SLEUTH.

SNYDER CORPORATION

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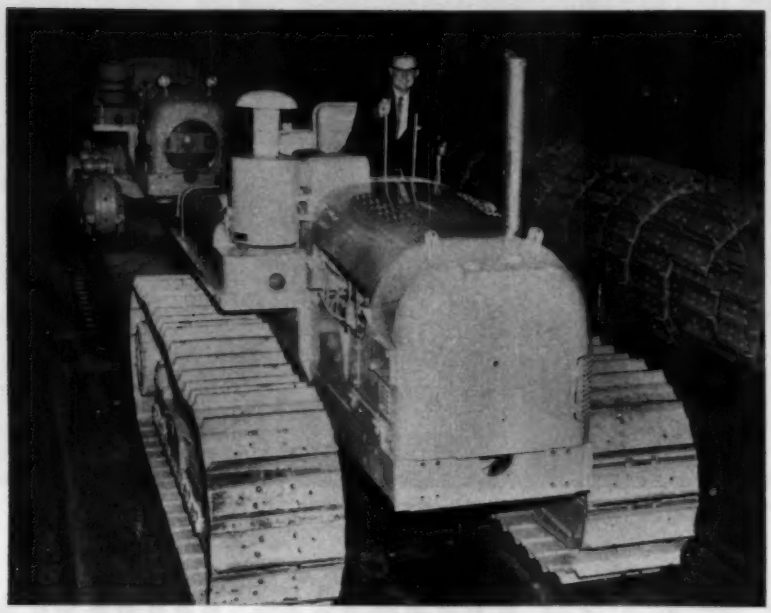
By JAMES C. KEEBLER Managing Editor



Euclid Div. of General Motors produced its first production C-6 crawler tractor at its new plant in Hudson, Ohio, last month. Shown driving the 21-ton powerhouse (211 net hp) off the assembly line is Plant Operations Manager, Jack Fairbanks.

Big Crawlers

AUTOMAKERS are known to use some highly automated production equipment for the manufacture of automobiles. The Euclid Div. of General Motors is showing that the principles of automation can be applied to the manufacture of crawler tractors as well.

Big Earthmovers

Euclid makes big earthmoving equipment, and the addition of crawler tractors and tractor shovels to the product line is giving Euclid representatives a more complete assortment of machinery to sell to those who move large tonnages of materials such as earth, rock, ore, and coal.

The division's new plant in Hudson, Ohio, is on a 400 acre site, has 15 acres under roof, and is part of an expansion program that has seen the division's floor space quadrupled in the six years that it has been a part of GM. Designed especially for the manufacture of heavy crawlers, the plant's sole products are tractors of the type pictured and of a twin type design that has two engines side by side to deliver twice the power. Plant capacity is about 2000 units per year.

Line Production

Modern methods and techniques are employed for line production of major subassembly components and finished units. There are 170 major machine tools, many custom-built heat treating installations, and special production machines linked in many cases by automatic conveyor systems.

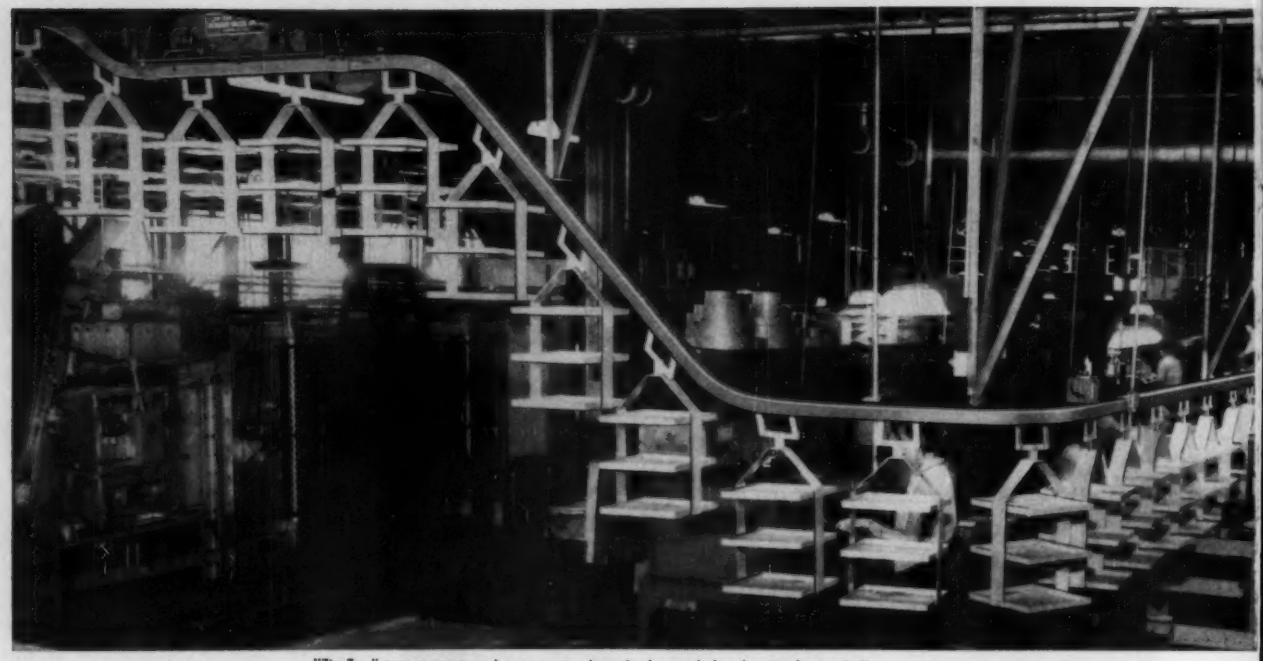
Deviating from the industry's practice of laying out such a plant, Euclid's divisional Manufacturing Facilities and Services Dept. did away with the idea of having a structural shop, machine shop, heat treat section, and assembly area. Instead the concept here is to achieve more economical production by reduced movement of material. Placing equipment in line sequences dictated by the manufacturing processes, rather than by the type of machine, means that the parts in process have to be moved around less.

Handling is minimized not only by the placement of equipment but also by the design features of the special machines. For example, on the gear case lines, each of the machine tools successively presents as many different multiple - spindle heads to the part as is feasible without reloading or refixturing the part.* Other component lines have more conventional type in-line and rotary transfer machines, yet here too there is evidence of a production philosophy that says the fewer times you let go and get a hold on the part again the better off the cost picture will be.

Heavy Weldments

Although this plant buys engines from GM Diesel Div. and Torqmatic Drives from GM Allison Div., it is not simply an assembly plant. Most of the structural and major subassemblies are made here. Illustrative of the in-line production arrangement for a major subassembly is the sequence of operations for the track roller frame: 1. Burn out plates. 2. Mill side plates. 3. Fit up members. 4. Weld basic frame. 5. Mill locating surfaces. 6. Bore and drill. 7. Tap. 8. Weld pads and brackets. 9. Inspect. 10. Assemble. 11. Paint. The boring and drilling operations are performed on an in-line transfer machine and the second welding operations are done on fixtures on merry-go-round carts such as are

*"On the Road Ahead," AUTOMATION, Vol. 5, No. 4, April 1958, p. 39, describes such machine arrangements.



"Zig-Zag" conveys parts and components where they're needed—when they're needed!

R-W "Zig-Zag"® CONVEYORS

"Zig-Zag"® FEATURES...

- **FLEXIBLE**... may be installed to go *up* to storage areas—*down* to production stations—*in, out* and *around* pillars, doors, machinery, etc. R-W "Zig-Zag" Conveyors carry unit loads up to 125 lbs. at speeds ranging from one inch to, if required, 100 feet per minute.

  The only conveyor of its type with a *proven multi-speed drive*... permits expansion at any later date. "Zig-Zag" is equally adaptable for installations of all sizes—no matter how large or how small.

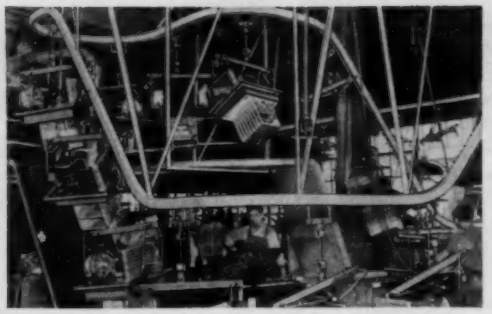
- **STRONG**... a continuous chain of alternate horizontal and vertical wheels travels through a rugged steel track much like water flows through a pipe. All moving parts of the chain are fully enclosed and protected from dust, dirt, etc. Chain, track, power units and accessory equipment are all designed to provide years of dependable, trouble-free service.

- **ECONOMICAL** to purchase, install and operate. Completely re-usable in case of plant changes... may be relocated, changed or expanded to meet plant alterations or expansion. One large system can be later changed to make two smaller ones or vice-versa.

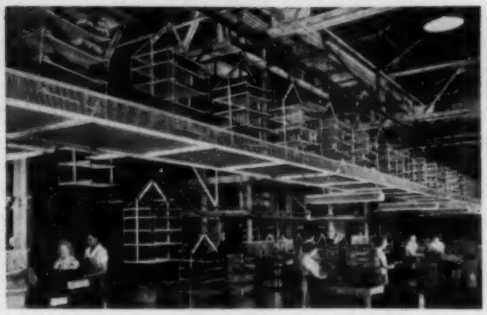
- **EFFICIENT**... R-W "Zig-Zag" is the *original* conveyor of its capacity in this field—available in one, top-quality grade—inferior components are never offered as a substitution. Designed, manufactured and backed by Richards-Wilcox, a leading firm in the overhead materials handling field for over 75 years.

REDUCE COSTS IN EVERY MANUFACTURING AND WAREHOUSE OPERATION

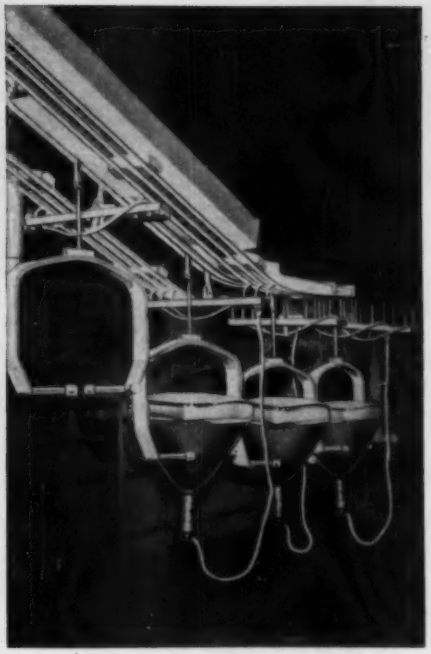
R-W "Zig-Zag" Conveyors will help you cut costs throughout the entire plant... providing a cost-reduction that could increase your annual profit as much as would a hard to achieve 50% increase in sales. "Zig-Zag" conveyors will reduce costs on an over-all basis by efficiently utilizing overhead space to provide a steady flow of parts and components... they help to make individual work stations more efficient and provide a visually apparent inventory storage in the "free" area under the building trusses. "Zig-Zag" Conveyors safely carry products through all production processes with increased speed and lower operating costs. Automatic devices of all types can be included in a "Zig-Zag" System to provide "machine-muscle" for the raising, lowering, moving and transferring of materials, components and products.



Flexible..."Zig-Zag" conveyors go exactly where you want them!



Provides part and component inventory in "free" overhead area!



"Zig-Zag" safely conveys TV tubes and similar products—reduces product breakage loss!

...PROFITABLY AND EFFICIENTLY CONVEY PRODUCTS UP-DOWN-IN-OUT and AROUND!

"ZIG-ZAG" to "TWIN-TRAK"... from automatic conveying to complete automation in the handling of materials

"Zig-Zag" components provide the backbone of R-W "TWIN-TRAK" Overhead Automatic Dispatch Systems... the ultimate in automated conveying of materials, components and products. R-W "TWIN-TRAK" Systems consist of one or more power tracks and as many storage or free tracks as desired, plus the necessary switches, carriers, automatic controls and power equipment. They not only move products from one point to another, but automatically and economically convey components to predetermined work stations from overhead storage or inventory banks. This unique system not only improves materials handling, but, because of its great versatility, permits the coordinated use of special new production techniques and machinery to produce products faster and more economically.

ON-THE-SPOT ENGINEERING SERVICE

Your local R-W Sales-Engineer is a factory trained materials handling specialist. He stands ready and willing to illustrate how an efficient R-W Overhead Conveying system will help you realize maximum production efficiency and economy. Whether you are planning a new plant or expanding present facilities, it will be to your advantage to let an R-W Sales-Engineer survey your problem and submit a recommended solution.

WRITE FOR ANY OF THE FOLLOWING CATALOGS

- R-W "Zig-Zag" Continuous Powered Conveyor, Catalog No. A-93R
- R-W "TWIN-TRAK" Overhead Automatic Dispatch Systems, Catalog No. F-192
- R-W "TRU-TRED" Monorail Systems, Catalog No. A-64
- R-W "SAFE-RAIL" Conveyor Equipment, Catalog No. A-94R
- R-W "458" Chain Conveyor Systems, Catalog No. A-570

Richards-Wilcox

MANUFACTURING COMPANY

"MATERIAL HANDLING DIVISION"

417 THIRD STREET • AURORA, ILLINOIS

Circle 673 on Page 19

used elsewhere in the automotive industry. Similar lines fabricate the heavy welded tractor frame.

More Track

Track components are required in much larger quantities. There are 43 shoes on each side of the crawler. Track subassemblies consist of right and left hand links, pins, bushings, and shoes which are bolted to the links. These components are made on more highly automated lines.

Link forgings of four types; right and left hand, large and small; are first milled on a rotary index machine, induction hardened on wear side, and then finish machined on a transfer machine that sizes the pin and bushing holes and drills the shoe mounting holes. Bushings are carburized in specially designed automatic equipment.

Material for track shoes is received in approximately 15-foot lengths of rolled steel shape. These lengths are first blast-cleaned to remove mill scale and then they are fed into a transfer press where, in successive dies, the complete machining of the shoe takes place, including the cutoff to length and piercing of six holes in each shoe. Feeds into and out of the press are automatic. Outcoming parts are automatically racked in groups of six and proceed through hardening and draw furnaces.

These groups leave the draw furnace and go through a cooling zone onto an automatic transfer-loaded arrangement that loads them one at a time onto 6-tier vertical racks of a power and free trolley conveyor system. At the loading station of the conveyor each rack is in turn lowered into loading position and when loaded is elevated again to the ceiling height of the conveyor. These racks move into a temporary storage zone and are delivered on demand to an automatic assembly machine that assembles links, pins, bushings, and shoes into track subassemblies.

Price of Progress

Euclid Div. employees have every right to be proud of this plant as a showpiece of the industry. Certainly, the problems of automating production of a crawler that lists for $32,000 present different challenges than automating production of an auto to list for one-tenth that price, yet there are many places where like principles apply.

Only one ominous note hung over the proceedings of an otherwise triumphant send-off of the plant's first production unit. The U. S. Justice Dept. had recently announced that it would like for General Motors not to own or control the plants that make Euclid road machinery.

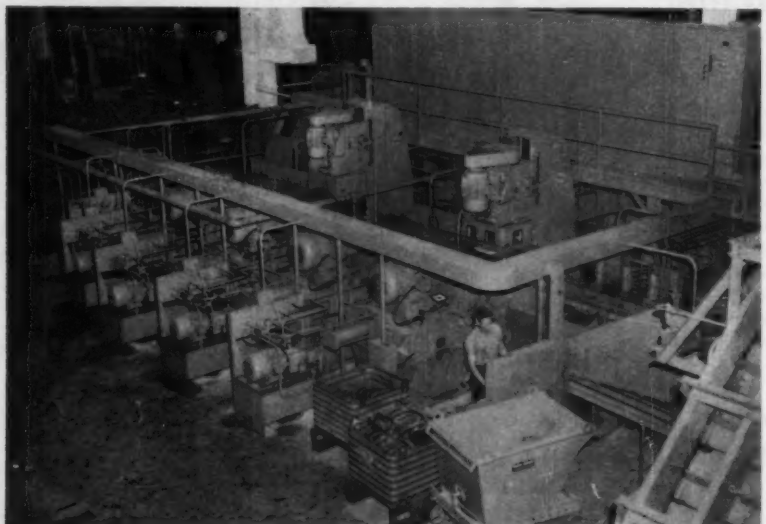
The plant management was understandably noncommenting to the questions from the gentlemen of the press concerning details of the case. The public relations representative could only say that the GM top brass had expressed surprise at the Federal action. The man on the street seemed to have other things on his mind.

To a populace concerned with big issues such as fake images on TV screens and whether or not a union has a right not to make steel, the road machinery issue did not look vital to everyday life. Yet pertinent to all these issues is the question: "Is bigness of itself bad?"

Few will argue that when big operators unscrupulously take advantage of their bigness at the expense of the little guy, it's time for the people's representatives to act in the people's behalf. However, it is suspected that sometimes people fear bigness solely on the grounds that it might turn bad, rather than on the basis of what has been done.

Some can see the irony in the situation where it appears that the rewards for success are harassment and suspicion. If over the years, GM has developed the talent necessary to move in with an organization like Euclid's and by plant expansion, use of automation techniques, and the host of other management tools that lead to more successful development of market potentials; then must they hide this know-how on the premise that its use will only serve to make the corporation bigger?

Big earthmovers do the work of many laborers with pick and shovel. Big earthmovers have a big market that shows all the signs of getting bigger. Big capital must back big thinking if such equipment is to be produced economically. No matter what the future of ownership will be it appears to this observer that the engineers who designed this plant and conceived its production processes have made a real contribution to automation technology. This experience should stand them and the nation in good stead to the extent that the know-how is available to the industry no matter what the outcome of any ensuing litigation may be.



An outstanding example of the use of automation in constructing "Euc" crawlers can be cited in the Greenlee machine which handles all the machining steps, except two, needed to convert rough forgings into track links. Precision quality control is obtained.

Circle 674 on Page 19→

Cleaner, cooler operation . . . less maintenance . . . longer, trouble-free life

HERE'S WHY: Ordinary d-c motor ventilation systems draw air in at the commutator end, contaminate windings by drawing carbon dust from commutator brush wear *into* the machine. In the new Life-Line® "H," this air flow is reversed. Air and carbon dust are expelled at commutator end . . . assuring cleaner, cooler windings . . . longer motor life . . . less maintenance.

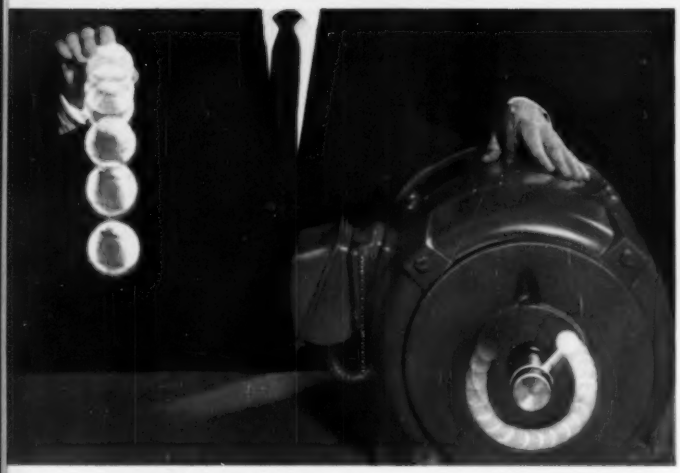
Plus . . . these other important advantages .....

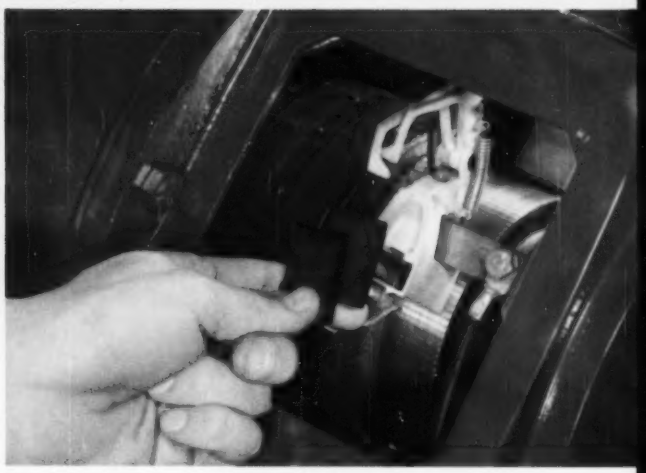
YOU CAN BE SURE...IF IT'S Westinghouse

These exclusive features of the new Westinghouse Life-Line H d-c motor guarantee top performance . . . longer, trouble-free life

TEN TIMES LONGER INSULATION LIFE . . . New silicone insulation in Westinghouse Life-Line® "H" d-c motors and generators stands up under temperatures which turn ordinary insulation to a cinder. High-temperature silicone insulation is used with the full complement of iron and copper required for low Class B temperature. Result: Life-Line "H" shrugs off emergency overloads and abnormal ambients to keep production rolling, maintenance down.

GREATER PROTECTION . . . most complete and advanced protection available in dripproof industrial d-c machines. Elimination of uncovered side openings . . . heavy, cast end brackets . . . effective seals throughout . . . all combine to provide outstanding resistance to liquids, vapors and dirt. This means longer life with greater reliability . . . minimum maintenance under all operating conditions.





FASTEST RESPONSE . . . 35 per cent increase in commutating ability . . . up to 55 per cent lower mechanical inertia . . . and up to 30 per cent reduction in electrical inertia mean that the new Westinghouse Life-Line "H" d-c motor provides the fastest acceleration, quickest reversing and closest speed regulation. This means more production, better product quality, minimum complexity of control.

SIMPLIFIED MAINTENANCE . . . With the new Life-Line "H," maintenance is not only substantially reduced but periodic inspections are also greatly simplified. For example: as shown above, Uniforce brushholder fingers lock out . . . brushes can be inspected or changed with one hand. And Uniforce tension remains constant throughout brush life . . . no need to adjust pressure as brushes wear.

For information about the ways you can profitably put the new Life-Line "H" motor to work, contact your nearby Westinghouse representative. Or, write Westinghouse Electric Corporation, P. O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa. J1-22122

YOU CAN BE SURE...IF IT'S Westinghouse

DECEMBER 1959

Now with Honor

He was a rare old friend from way back. For many years —more than he liked to remember—he was chief engineer in charge of his company's manufacturing operations. A sidelight to the long evening's conversation made a lasting impression.

Times had changed. It seems a few years back he had been promoted to the position of technical advisor to the president. Asked how he liked it, the answer was definitely affirmative.

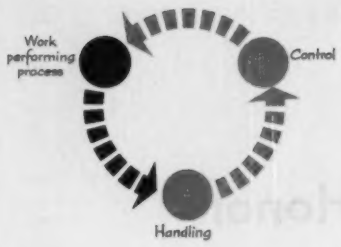
"You know," he said, "it really gave me a jolt at first. I found that suddenly I had a sympathetic ear from the president. He listened to and read my proposals for making our operations more automatic to cut costs. Today, we're really competitive.

"Some of the things we have done I proposed many years ago as chief engineer but none were considered seriously. Now, I have no trouble at all getting the proper management backing necessary to develop these really novel automation ideas."

My only comment was that the point had been made many years ago in the Bible about a prophet being without honor in his own home town. But, the words of the old proverb can be reversed in practice. To do so effectively, top management must establish a competent manufacturing engineering group, provide good channels of communication and back it with full confidence. By so doing, it will be found the possibilities of automation in industry have hardly been tapped.

EDITOR

AUTOMATION



PART 1 – PRESSES FOR

AUTOMATED PRESSWORKING

By **LEE D. MILLER,** Associate Editor

PRODUCTION of metal parts through work performed in presses is one of the major activities on the American industrial scene. The applications of metal parts made by pressworking range from shoe buckles to missiles, from wrist watches to farm tractors. With the widespread importance of presses in manufacturing operations, it is not surprising to find that advantages of automation have been applied to pressworking.

Good Old Days?

However, since the basic concept of pressworking has been applied for many years, it can be surprising to consider the many developments that have come about in the growth of pressworking automation. Not so long ago as time flies, most presswork, even in the big automotive and appliance shops, was largely a matter of manual handling and control. Each pressworking operation was an island unto itself, linked to other operations only by its need for material to be worked and a place to dispose of the processed material.

For small parts, each individual operation was usually performed by one operator feeding blanks or previously processed parts from a skid or tote box, tripping the press, and removing or checking to see that the part and trimmings were ejected to another skid or box. Working of large parts was about the same, except that more than one worker was required because of weight or size of parts.

The pace of each operation was largely determined by the specific operators. Erratic performance did not affect the other operation islands as long as the piles of work between successive opera-

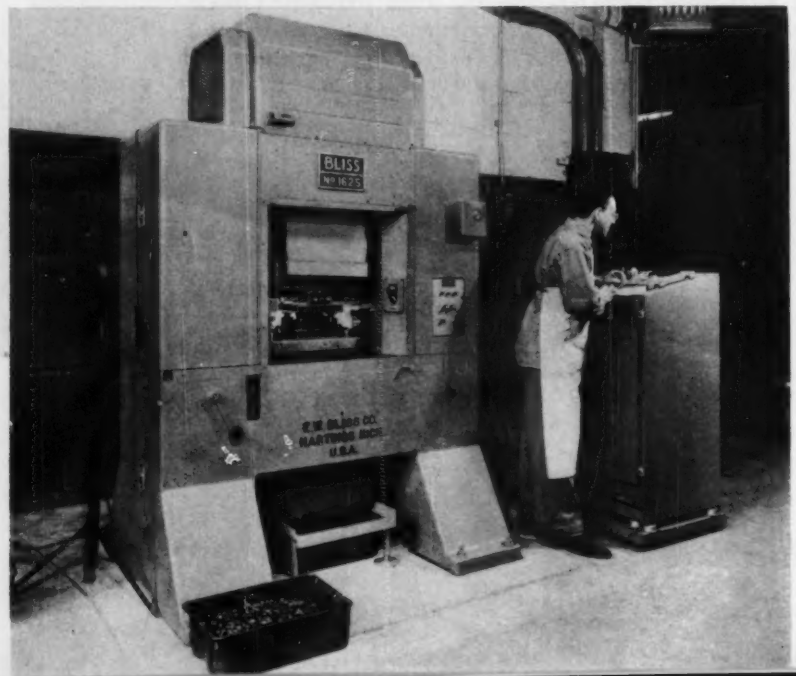


Fig. 1—Operating at 1000 strokes per minute, press built by E. W. Bliss Co. uses a triple die to produce retaining rings at rate of 3000 per minute. Coil stock 0.050 inch thick and 3 inches wide is pulled into the press by a roll feed at speed of 500 inches per minute. Press, feed, and controls were supplied as integrated unit.

Developments in presses, handling equipment, and controls have made automated installations practical in small and large press shops. By integrating elements with desired features, the manufacturing engineer can plan economical production setups for a wide range of pressworking applications. This first part of a three part series records some of the press features available for improved operations. Succeeding parts will note interesting handling and control elements.

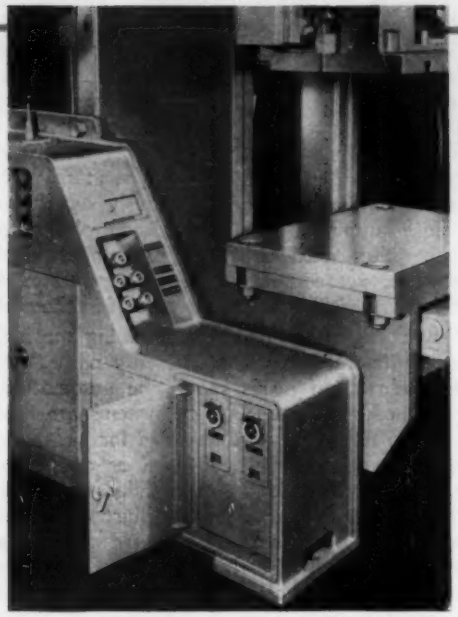


Fig. 2—Design of modern open-back inclinable press by Niagara Machine & Tool Works reflects emphasis on co-ordination of press, handling, and control elements. Press has built-in rotary limit switch for synchronized electrical control, built-in interval timers, and built-in controlled air supplies with air line receptacles for die doper, die kicker, and die lifter.

tions stayed within wide limits. Because of the performance-balancing problems, these piles of in-process inventory often required provision of considerable storage area. In addition they also represented a sizable investment of capital.

Economically, the use of manual handling and control usually meant that expensive presses were not operated at their maximum cycling rates. This, in effect, amounted to a fixed penalty against press investment. Some number of dollars was sitting idle merely because manual handling and control actions could not keep pace with capacity cycling rates. Under such conditions it was of little use for press manufacturers to improve their designs with the object of increasing maximum cycling rates of the presses themselves.

One of the cruelest facts about such manual operations, even at reduced cycling rates, was the high degree of hazard for the operator. Long-time employees on manually fed and controlled presses could be counted as lucky if they could count to ten on complete fingers of their own. All too many were unable to do so. Fatigue and inattention, natural with the mechanical repetition of manual loading and unloading, caused lapses in the precise co-ordination required for safe operation. Equipment malfunctions such as the dreaded accidental repeats added to the physical losses suffered by press operators.

▶ The Better Life

Progressive developments in pressworking have truly led to a better life for all. Higher rates of production and consistently higher utilization of press productive capacity have benefited the whole pressworking organization. Conditions of work and rates of pay have improved for the operators, and the shrinkage of pressworking profits has been avoided or slowed. Finally, the general public has gained through the availability of greater quantities of press made products at lower prices than would otherwise be possible.

Basic mark of the pressroom changes bringing this better life has been the integration of work performing, handling, and control functions in automated equipment installations. Many of these equipment installations have involved a single operation in a single press. But, significantly, a number of installations have involved a series of operations being performed in a line of several presses all interlocked with automatic handling and controls.

Whether the automated installations have consisted of a single press or a line of presses, they have been made possible by equipment developments in the three basic areas of work performing, handling, and control.

Much of the development in handling and control was necessary just to utilize a greater portion of the work performing capability of existing presses. Many automated pressworking installa-

tions are based on presses of long standing designs supplemented by handling and control equipment applied by the user. However, press designs have been improved to increase rates at which work can be dependably performed for extended periods. These improvements have also included features to increase versatility of the basic machines and compatibility with other elements for automated installations.

▶ Some Press Design Details

Because of the higher speeds and greater dependability demanded of automated pressworking equipment, *Fig.* 1, many improvements in press details have been developed. An important trend in this regard has been to make provision in the basic work performing equipment—the press itself—for easy application of integrated handling and control equipment. In fact, presses are available directly from the manufacturers with integral handling and control equipment. One of many possible illustrations of this trend is shown in *Fig.* 2. This open back inclinable press is available from the manufacturer with a built-in system for synchronized operation of related equipment. A rotary limit switch is positively linked to the crankshaft of the press. Adjustable setting of individual electrical contacts in this switch unit allows precise programming of related functions in time with the press stroke.

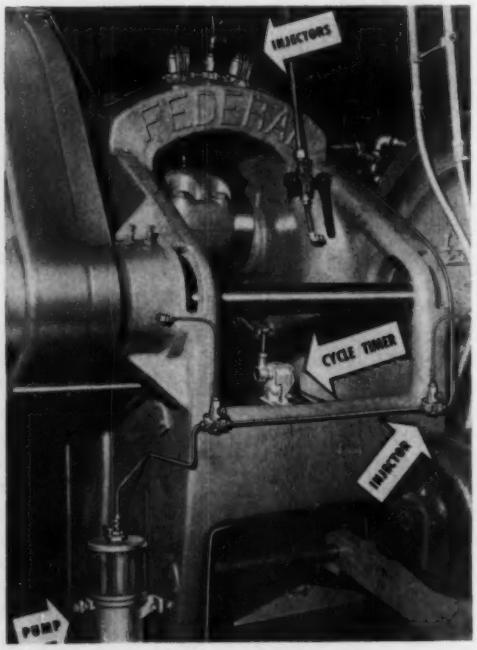


Fig. 3—Air-operated lubrication system, controlled by press operation, automatically lubricates bearings on the machine without interruption of operation. System shown was built by Lincoln Engineering Co. and applied to a machine built by Federal Press Co.

This particular press design includes controlled air supplies for die doper, die kicker, die lifter, and miscellaneous air tools. A die doper can thus be readily used to automatically lubricate blanks and die; a die kicker to automatically position blanks in the die; and a die lifter to automatically eject stampings from the die. The air supplies are available through receptacles on the leg of the press. Adjustable timing relays triggered by the rotary limit switch are also included for functions requiring timed intervals.

A big milestone in mechanical press operation has been the application of pneumatically operated friction clutches and associated brakes. The positive-type mechanical clutches and constant drag brakes previously used had serious drawbacks for automated operations. Once such a clutch is engaged, the crankshaft must go through its complete cycle and return to top center before the clutch can be disengaged. By contrast, the air operated friction clutch can be disengaged and engaged at any point in the cycle. Such ability is obviously very important since automatic handling and control elements must be interlocked with different stages of the press cycle; yet equipment must be protected by provision to stop the press at any point in the cycle.

With increased emphasis on obtaining the highest utilization rates possible, it is only natural that routine lubrication needs should be automatically met on modern presses. Many systems are available and in use. They are designed for installation on new units being built, as well as on existing units. Such systems can be controlled electrically, mechanically, or manually. The illustrative application in *Fig.* 3 shows an air-operated system controlled mechanically by the stroking of the press. By performing the lubrication function automatically, regular application of lubricants is accomplished in metered amounts at all desired points. Electrical interlocks connected to the lube lines can shut a press down if lubrication pressure is not sufficient. With the timing of lubricant applications automatically based on actual cycling of the machine, improved protection of moving parts can be obtained. Use of automatic lubricating systems can also allow reduction of clearances between moving parts, thereby increasing accuracy and die life.

The problem of accuracy and smooth operation at high speeds has led in some cases to the building of presses having preloaded ball bearings on the ram, *Fig.* 4. The V-type raceways on ram and uprights require no clearance for lubrication. This contributes to very precise ram travel and increased die life. The particular unit shown was designed to punch slots and holes in silicon steel circles 0.025 inch thick. These cookies are electric motor laminations that this press punches at 300 strokes per minute.

Such punching has frequently been done on inclined presses to take advantage of gravity in work loading and ejection. This press with ball bearing gibs would normally be built with four such gibs for vertical operation. To allow the user to incline the press if he desires and still maintain high ram accuracy, six preloaded ball bearing gibs

Fig. 4—Six preloaded ball bearing raceways guide the ram on this press built by Precision Welder and Flexopress Corp. It punches slots and holes in silicon steel discs 0.025 inch thick at a rate of 300 strokes per minute. Length of stroke is 2 inches.

were used. One additional gib was added on each side of the ram. This means that if the press is inclined, the weight of the ram will be carried by several gibs rather than only the back two.

Because of the increased emphasis on integrated lines of press equipment, it has become even more important to develop means to speed up cycles on slow units in a line. Double action mechanical presses for deep drawing operations often have slower stroking rates than single action presses which may be used in the same production line. The slower rate of these drawing presses usually makes them the bottleneck operation for the whole line. This rate is based on the ram speed at which metal is to be drawn. Presses are available, however, which incorporate electrical, or mechanical stroke slowdown actions. In these presses the basic stroking rate is much faster than the desired drawing rate, but the ram is slowed down during drawing. On hydraulic drawing presses, the change of speed during the drawing portion of a cycle is readily obtained by suitable hydraulic controls. In effect these arrangements for changes of speed are the same as the rapid advance, feed advance, rapid retract cycle used in many machining operations.

▶ Moving Bolsters

One of the very interesting developments in design of heavy presses is the availability of production presses with moving bolsters. Sliding bolster presses are available from several builders; *Fig.* 5 illustrates one design. With this feature, dies can be rapidly changed even in large presses. The resulting increase in time available for actual production has been figured in some cases as meaning that two presses equipped with sliding bolsters could do the work of three conventional presses.*

A moving bolster press is provided with two bolsters which can move into or out of the press through openings in the uprights on the sides of the press. While the press is performing operations in a die mounted on a bolster in the press, another die can be set up on the second bolster beside the press. The die being set up can conveniently be moved to the bolster by overhead crane, die truck, or lift truck. After the die is properly located on the bolster, it is bolted in place.

Construction of the bolster is usually such that the die may be completely set up, including pressure pins to contact the die cushions in the bed of the press. A movable plate in the bottom of the

*J. J. Littley, "Sliding Bolster Presses," 23rd Annual Machine Tool Electrification Forum, Westinghouse Electric Corp., April, 1959.

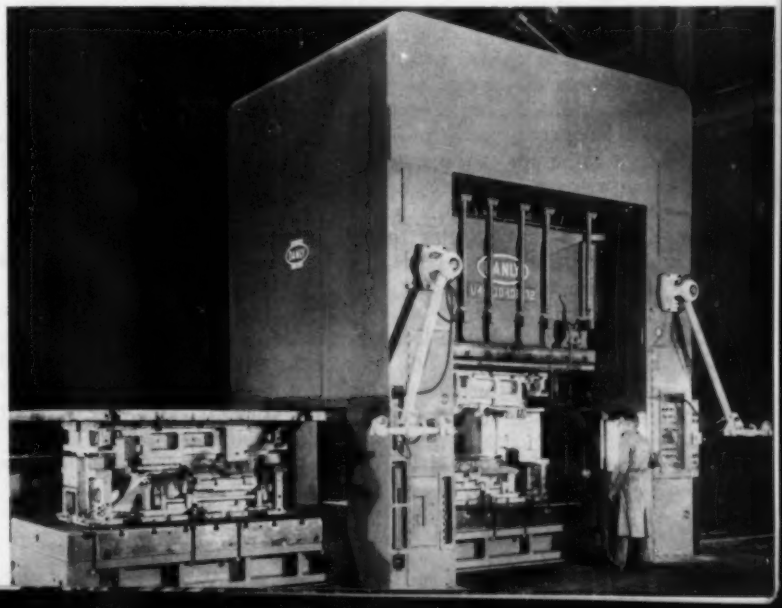
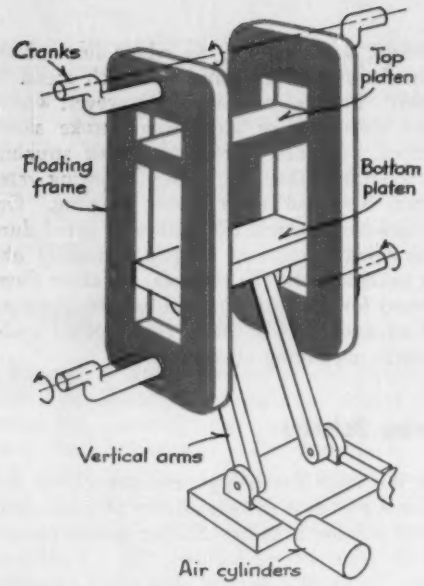


Fig. 5—Important press feature, now available from several press manufacturers, speeds die changes by providing two moving bolsters for press. The unit shown was built by Danly Machine Specialties Inc., and illustrates the fact that a die may be set up on one bolster while another die is used in the press. For changeover, die in press is unclamped and rolled out, new die rolled in and clamped. Change requires minutes rather than hours.



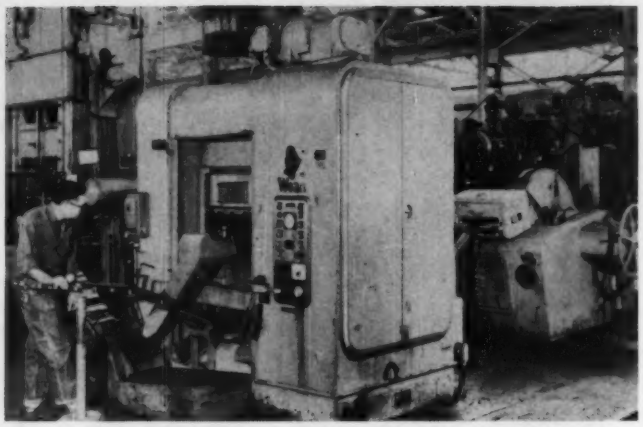
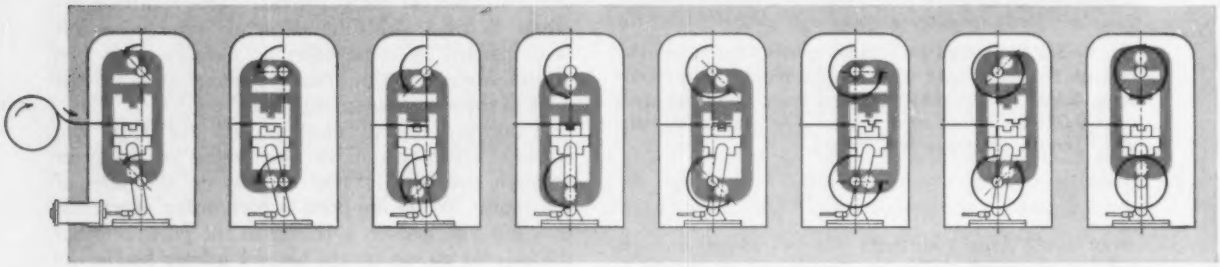


Fig. 6—Stock advances continuously while it is worked in this press built by Wean Equipment Corp. As sketches illustrate, the dies are carried by a floating frame so that they move with the stock as they close. Photograph shows a unit operated at 350 strokes per minute with a seven-stage die to blank and form automobile transmission vanes. Stock 0.042 inch thick is payed off a coil in unit at right in photograph.



bolster holds the pins up in place while the bolster is out of the press. When the bolster is in position in the press, the die cushion in the press bed moves the plate up to exert force on the pressure pins. In many installations, auxiliary air cylinders are mounted in the floor under the die-setting positions so that cushion action can be simulated during setup to insure that pressure pins do not bind. Where desired, these setup stations can also be equipped with die opening devices in which a mechanism can lift the punch for maintenance or inspection. Design of the bolsters can be such that the bolsters also may be carried away by overhead cranes to a centralized die setting area.

When the die has been set up, the wheeled bolster can be moved partly into the opening in the upright to be out of the way until it is required. To change over from one die to another, the punch of the die just used is unclamped from the slide and the bolster carrying that die is unclamped and moved out of the press by a drive mechanism. At the same time, the waiting die is moved into the press on its bolster.

The bolster may be located against positive stops and lowered over locating pins or keys. Lowering of the bolster can be accomplished by retracting hydraulic cylinders supporting the sections of tracks on which the bolster wheels rest. The bolster and die are then supported by the press bed. Raising and lowering are pushbutton controlled, and the bolster may be clamped to the bed manually or automatically. When the slide is brought down to the die, the punch can be automatically or manually clamped to the slide. Electrical interlocks can prevent operation of the press until all clamps are properly positioned and locked. The new die is then ready to function in a matter of perhaps six minutes as compared to four or six hours required to change over a conventional press.

Since the wheeled bolsters can move dies in and out through the sides of presses, a compact line can be arranged with handling equipment from press to press. The handling equipment does not have to be removed when dies are changed. This feature may also allow presses in a line to be more closely placed than usual, but extra space may be required between adjacent lines.

▸ Automatic Slide Positioning

Another feature contributing to quick die changes is automatic slide positioning to adjust die shutheight—the distance between the bolster and slide for a particular die in its closed position. Filler plates, adjusting nuts, and hand cranks have been used to adjust shutheight. Now motorized slide adjustment is usually provided on large presses and

sometimes even on small presses. Such motorized drives can be automatically controlled by a simple dial setting. To adjust the shutheight for a particular die, the desired shutheight is set on a dial, and the slide is automatically adjusted to that height with an accuracy of 0.001 to 0.002 inch.

Where desired, the positioning may be a two-speed operation using a rapid traverse rate to make most of the adjustment. When the preset shutheight is approached, the drive system can be automatically shifted to a threading speed. The controls for these actions can be static circuits mounted within the uprights of the presses. They can include interlocks such that the clutch of the press remains disengaged while the slide is being repositioned.

Automatic slide positioning is also useful for speeding up or increasing safety of tasks besides initial die setup. For instance, on a press with a very short stroke, it may be very difficult to clear a jam in the die. But with automatic slide positioning, the shutheight may be changed from 3 to 13 inches, the jam cleared, and the shutheight readjusted to the running setting by the turn of a dial. Similar use of automatic slide positioning can open the dies sufficiently for a die setup man to make minor changes or adjustments to a die without removing it from the press. While he is doing this work, the opening can be great enough so that he will not be injured even if the press should cycle. Use of safety blocks and turning off of press power would still be wise of course.

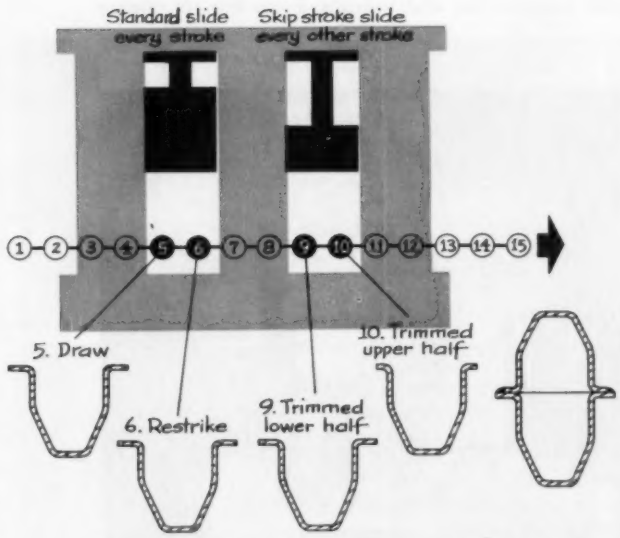

Standard slide every stroke
Skip stroke slide every other stroke
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
5. Draw
6. Restrike
9. Trimmed lower half
10. Trimmed upper half

Fig. 7—Sketch illustrates a multiple slide press built by Clearing Machine Corp. to simultaneously produce two parts requiring two identical operations and different trim operations. The identical draw and restrike operations are performed on both parts by first slide. Second slide carries two different trim dies but only brings them into contact with the work on every second cycle of the press.

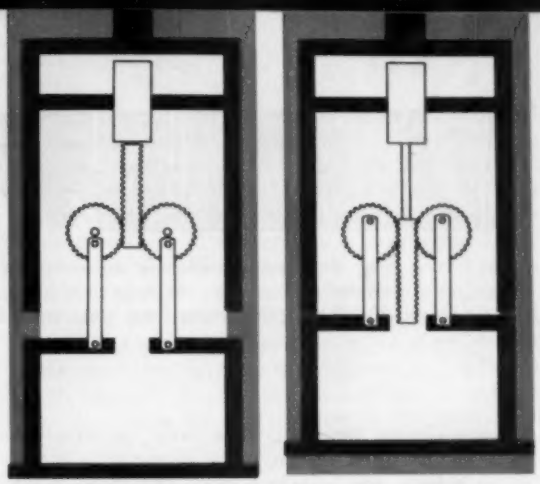


Fig. 8—Built into the second slide of the press in *Fig.* 7 is a mechanism to prevent die closure on alternate strokes. The slide has an upper and a lower section, each independently guided in the same gibways. The two sections are connected by pitmans suspended by eccentrics. Rotation of the eccentrics changes the height from the lower section to the press crankshaft and provides a stroke skipping effect even though the crankshaft and slide continue to cycle.

Nonstop Presses

An interesting development in basic press concepts is illustrated by the press shown in *Fig.* 6. Stock is continuously fed into this machine in strip form. Advance of the material is not interrupted even during the blanking, forming, or other operations that are performed. Instead, the dies are carried by a floating frame in such a manner that they can close on the stock and move with it.

Since the press mechanisms operate continuously, no clutch or brake action is required. This point deserves special mention when stroking rates are in the 400 to 600 strokes per minute range of some of these presses. Major maintenance points on a single-stroked press are the clutch and brake. They naturally must be serviced frequently because of the repetitive loading and unloading which they undergo. Continuous operation with this press design also avoids repetitive severe shock loads on crankshafts and their bearings and adds to the favorable maintenance picture.

Stock can be fed into presses of this design with individual feeds per stroke up to 96 inches. Stroke of slide may be as much as 12 inches. Production examples on some small parts include compound drawing at 450 strokes per minute on 0.020-inch stock indexed 3¼ inches per stroke; and 300 strokes per minute on 0.078-inch stock indexed 4⅞ inches per stroke. It has also been used as a shear to cut sheets at high speed from coil stock.

Stroke Skipping

To increase the versatility of that continuously fed nonstop press, provision is made to allow stock to pass through the die opening at selected intervals

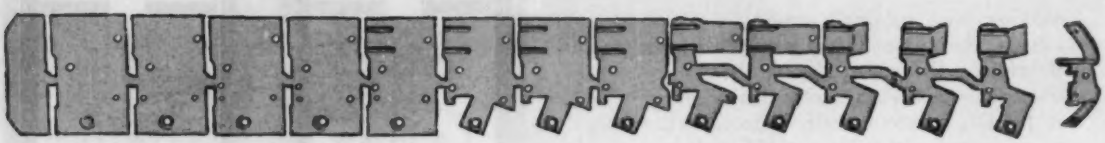


Fig. 9—Drawing indicates succession of operations in production of a brush holder on four-slide machine built by U. S. Tool Co. Inc. Rate of production is 80 pieces per minute from steel stock 0.050 inch thick by 3.780 inches wide.

without closing the dies. The press continues to cycle in the usual manner, but whenever a cut is to be missed, air cylinders move the pivot point supporting the bottom platen and die. Because of the pivot point displacement the dies will not close.

Another means of keeping a die open while the press continues to cycle has been applied in a more conventional type of press illustrated by *Fig.* 7. This was a special press built to simultaneously produce top and bottom halves of a compressor housing. The parts were designed so that the same draw and restrike dies would form both parts from identical blanks. However, each part design required a different trim die.

The single press that performs these operations was built with two slides. The draw and restrike dies are mounted on one slide, the two trim dies on the second slide. The second slide is designed in such a manner that its stroke is shortened on every second cycle so that the trimming punches do not contact the work on those cycles. Stock is thus indexed twice for each stroke on which trimming occurs.

An internal mechanism in the second slide contracts the slide vertically to allow pieceparts to pass untouched below the slide. This slide is composed of two slide sections which are guided in the same gibways, *Fig.* 8. The upper section is continually driven up and down between constant limits by the press drive. The lower section of the slide carries the punches and is attached to the upper section through four pitman arms supported by eccentrics on the upper section. Through a rack and gearing arrangement, a pneumatic cylinder in the upper section can rotate the eccentrics and change the lowest point of travel for the lower slide.

▶ Other Multiple Slide Uses

Besides the application of multiple slides in heavy presses for stroke skipping, such a design is frequently advantageous in meeting load demands. Where several operations are performed by a single slide, unbalanced loads at successive stations tend to cock the slide in its ways. Also, deflection of the slide itself may become excessive. These effects lead to excessive wear on gibs and premature dulling of dies because punch and die do not close squarely. Mounting of dies on more than one slide minimizes these problems.

Use of multiple slides in lighter machines such as the horizontal four-slide machines has permitted the progressive piercing and complete forming of intricate parts like those indicated in *Fig.* 9. Multiple slide machines have also been applied to simultaneous fabrication and assembly operations. The machine illustrated in *Fig.* 10 features three slides driven by a single crank. The action of the center slide is 180 degrees out of phase with the outside slides. If stock is fed to both outside slides, two separate parts can be made, transferred under the center slide, and press assembled.

Other slide arrangements have been used to speed setting of multiple dies or accommodate versatile setups for quick changeover from one part to another. One such arangement known as a split slide, *Fig.* 11, provides two individual slide elements side by side between one pair of uprights. Each element has a means for individual height adjustment. These means can be automatic slide positioners such as were mentioned earlier. Dies for two consecutive operations can thus be independently adjusted. Where desired, dies for two different workpieces can be mounted on the split slide elements. Changeover from one piecepart to the other is accomplished by running up the slide adjustment on the die which has been in use, and running down the adjustment

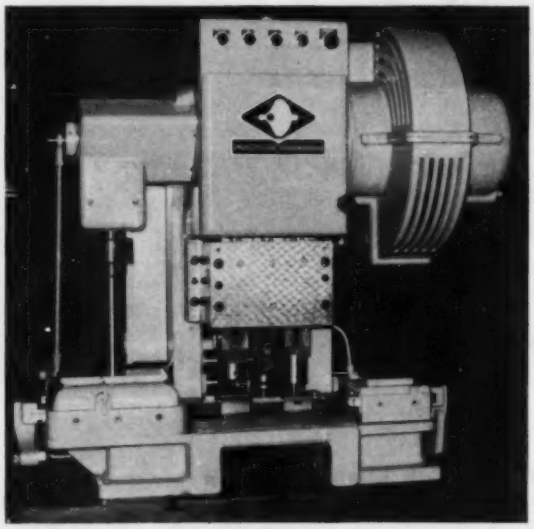


Fig. 10—Multiple slide machine by Multi-Autoform Corp. has three independent slides driven by a single crankshaft. Motions of two outside slides are 180 degrees out of phase with respect to motion of center slide.

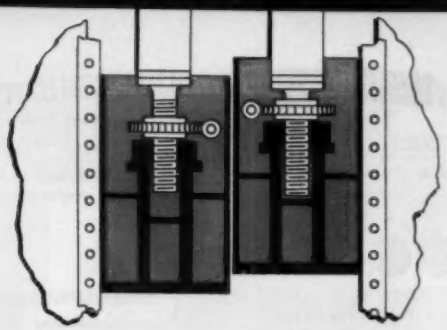


Fig. 11—Slide configuration indicated by sketch is known as a split slide construction. Two slides are mounted between a single pair of uprights. Each slide is independently linked to the crankshaft and may be individually adjusted. Clearing Machine Corp. has built a press with such a design to produce both home washer tops and home dryer tops. Changeover is a simple matter of changing slide adjustments.

on the die which is to be used instead.

One application of split slides for quick changeover between two parts is in a press used to produce dryer tops for a period of several hours, switched to washer tops for several hours, and alternated thereafter between the two parts. Requirements for the two workpieces were such that a single modern press could produce quantities required for both. To avoid excessive stock floats and save space and costs in handling and storage, it was necessary that the one press be easily shifted from production of one part to production of the other. The press designed to handle this requirement incorporated two split slides and one large conventional slide. The first two operations on dryer tops require different dies than the first two operations on washer tops. The two split slides allow rapid changeover of those two operations. The remaining six operations are identical for both pieceparts and are performed by the one conventional slide. All the operator needs to do to change over the press from dryer tops to washer tops is reset a switch.

Some similar effects for rapid adjustment of individual successive dies have also been obtained by mounting two or more subslides in gibways carried by the main slide. Combinations of these various slide constructions allow a wide range of efficient applications with considerable flexibility as to the use of a single machine. A few of the many such combinations possible are indicated by *Fig.* 12.

▶ Handling and Control

These examples, then, have illustrated some of the press features that are available to increase dependability and versatility in automated pressworking installations. But the presses form only one of the three phases involved in an automated unit. Stock and workpieces must be moved into and out of the dies, and the cycling of all elements must be controlled so that proper synchronization is maintained. Two succeeding parts of this article will discuss some of the developments in the handling and control phases of automated pressworking.

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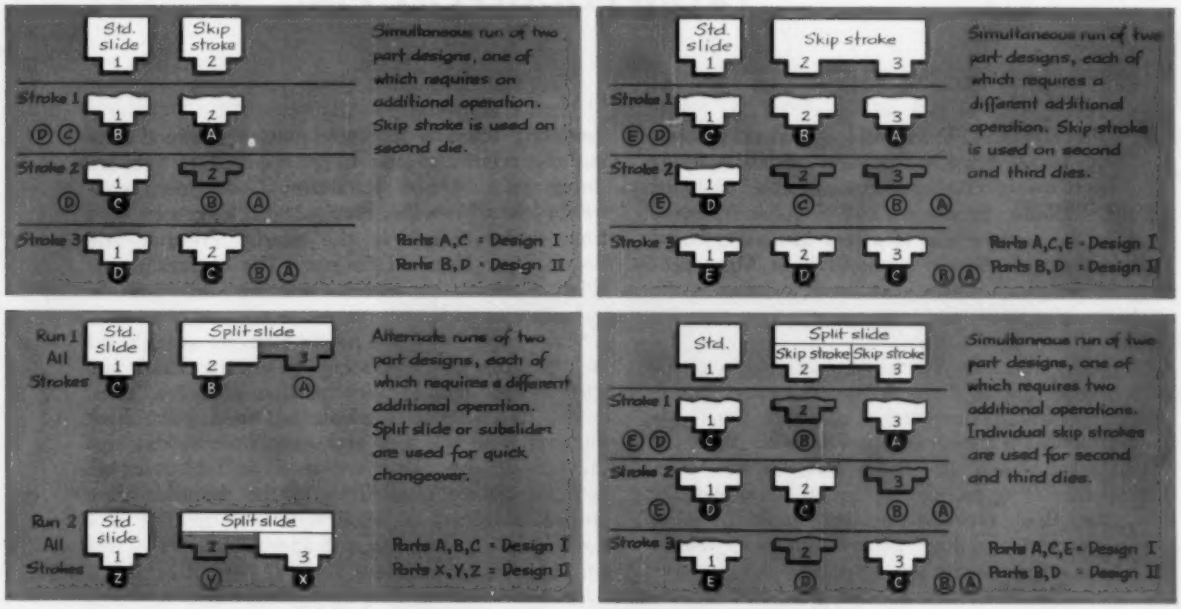
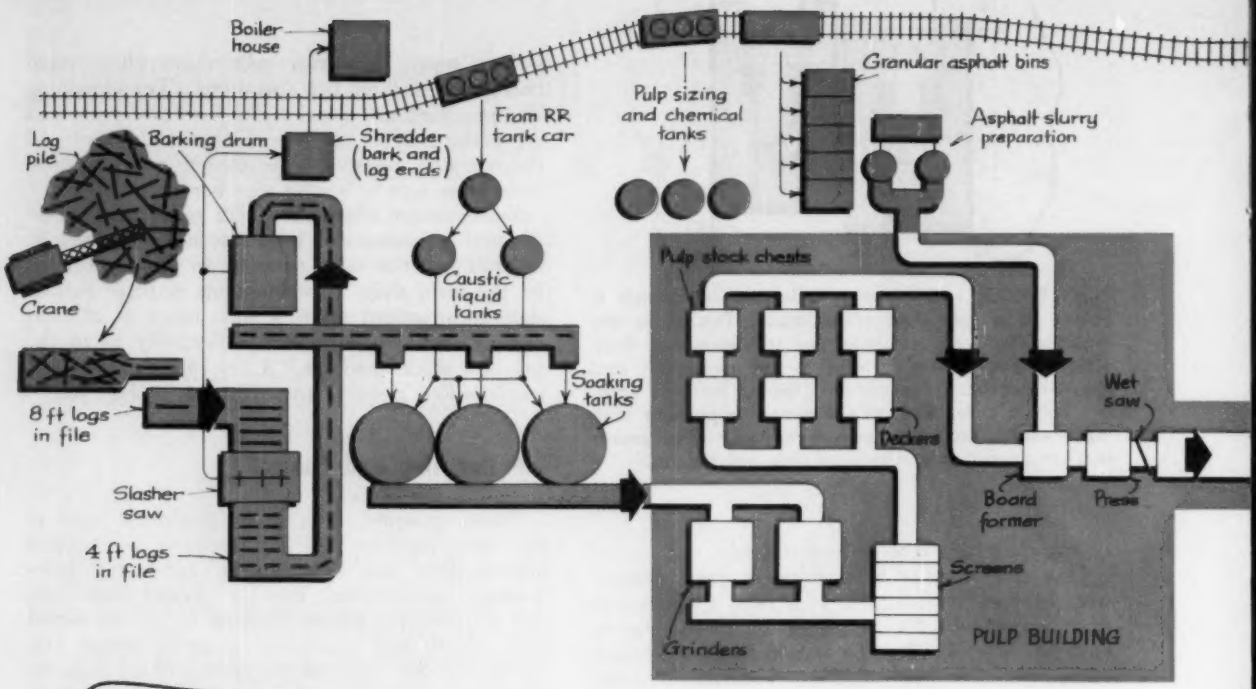

Std. slide
Skip stroke
Simultaneous run of two part designs, one of which requires an additional operation. Skip stroke is used on second die.
Stroke 1
Stroke 2
Stroke 3
Parts A,C = Design I
Parts B,D = Design II
Std. slide
Skip stroke
Simultaneous run of two part designs, each of which requires a different additional operation. Skip stroke is used on second and third dies.
Parts A,C,E - Design I
Parts B,D = Design II
Run 1 All Strokes
Split slide
Alternate runs of two part designs, each of which requires a different additional operation. Split slide or subslides are used for quick changeover.
Run 2 All Strokes
Parts A,B,C = Design I
Parts X,Y,Z = Design II
Skip stroke
Simultaneous run of two part designs, one of which requires two additional operations. Individual skip strokes are used for second and third dies.

Fig. 12—Combinations of various slide configurations permit many different processing plans. Four possible plans suggested by Clearing Machine Corp. are shown to make two different parts on presses with different slide combinations.



AUTOMATION TODAY

MAKING INSULATING BOARD

FROM LODGEPOLE PINE

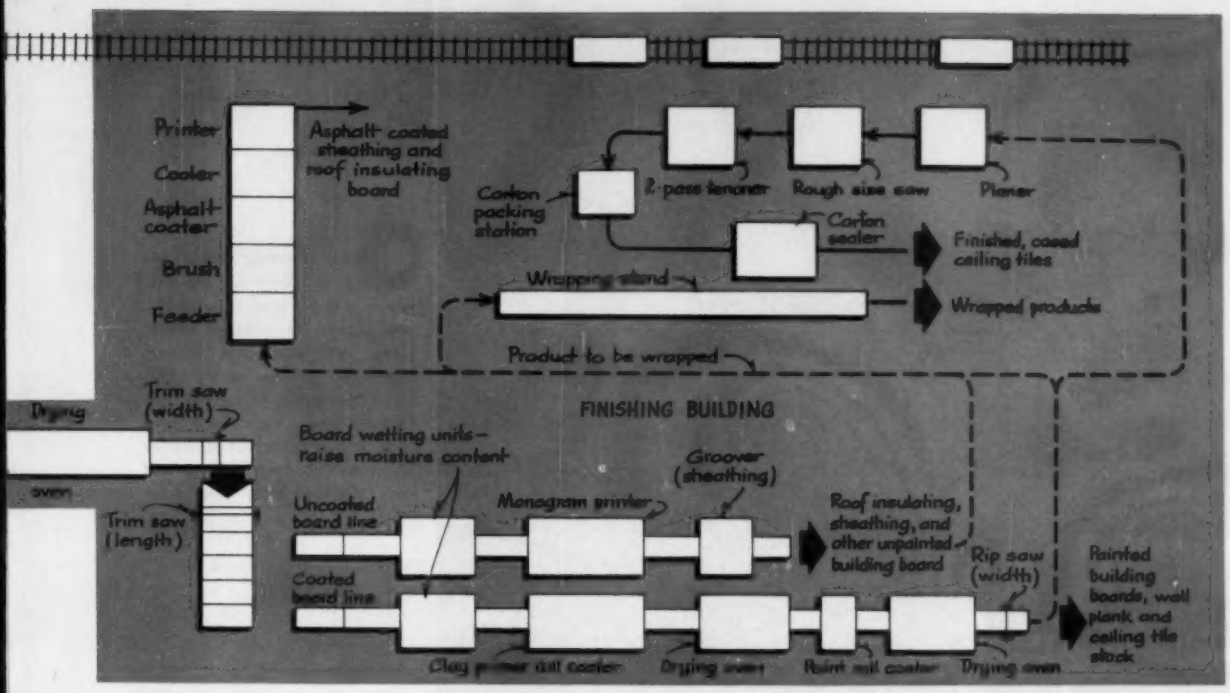
OPPORTUNITY to build a modern processing plant from the ground up, embodying latest manufacturing technology, was exploited by the Building Products Div. of Johns-Manville Corp. in the construction of a new insulating board manufacturing facility at Klamath Falls, Ore. Features of the plant reflect years of experience in the operation of similar plants in other sections of the United States and Canada.

Insulating board is a product resulting from the formation of pulpwood fibers into continuous sheets by wet processing, pressure, and heat. Small air spaces trapped in the sheet, together with the wood fibers, create a structural board material with good thermal insulating properties. From this basic product, the plant produces natural finish building board, decorative ceiling panels and wall plank, insulating board sheathing, acoustical panels, and roof insulation. For some of these products, asphalt slurry is incorporated in the wood pulp at the sheet forming stage.

The basic raw material the plant uses in making insulating board is lodgepole pine, a softwood having the relatively long fibers required to produce strong pulp. Under long-term Government contract, Johns-Manville may obtain lodgepole pine from timber stands in the nearby Fremont and Rogue River National Forests. The operation provides a major commercial use for this type of resource.

Trees from 6 to 11 inches in diameter are selected and prepared for processing by cutting them into logs 8 feet long. Every portion of felled trees, except the twigs and needles, is used. The bark removed from the logs and scrap from sawing operations at the plant are used as fuel. As an example of the capabilities of the manufacturing process, a volume of wood equivalent to that of a log 6 inches in diameter and approximately 6½ feet long can be made into a sheet of insulating board 4 feet wide by 8 feet long by ½ inch thick.

Before construction of the new plant could be justified economically, it was necessary for Johns-Manville to determine the technical feasibility of



1 Schematic plan view of Johns-Manville Corp. processing plant illustrates flow paths for material as it is converted from raw log state to several types of insulating board products. Lodgepole pine logs, approximately 8-feet long, are removed from piles in storage yard and placed on conveyor by crawler crane. Logs proceed through sawing, bark removal, and chemical processing steps and are converted to pulp by grinding, screening, and decking operations. Pulp, stored in stock chests, is then introduced to forming machine that forms and presses the pulp into a continuous, wet sheet that may be up to 14-feet wide. Asphalt slurry may be added for certain types of products. Wet sheets are then cut into discrete panels, or mats, in lengths up to 24 feet. After drying in a conveyor-type oven, panels are sawed to width and length and directed to one of two finishing lines. On one line, uncoated products are moistened, marked, and may be grooved. On other line, the panels are moistened, prime coated, finish painted, dried, and sawed to desired widths. Panels from both finishing lines may be wrapped or stored unwrapped; panels from the coating line may be further processed to form ceiling tile products which are cased. Finished products are loaded in cars by fork trucks in rail loading area inside finishing building.

using lodgepole pine as the basic raw material for manufacture of insulating board products. Accordingly, several carloads of the wood were shipped from the proposed source to an existing insulating board plant for the purpose of research and experimentation. The experiments were successful, resulting in the production of an insulating board of satisfactory quality from the test samples. Plans and negotiations for the plant were then started.

Located on approximately 290 acres, the plant includes six general groups of buildings having a total floor area of 285,000 square feet. The buildings

2 General layout of buildings and outdoor handling and processing facilities is shown in aerial view of plant. Products manufactured from pine logs include building board, decorative ceiling panels and wall plank, insulating board sheathing, and roof insulation.

3

Cut and trimmed logs are stacked in piles in storage yard at input end of processing plant. A crawler crane picks up logs and places them in random orientation on conveyor leading to slasher saw. Eight-foot long logs are aligned at a transfer point before being cut into four-foot lengths by saw.

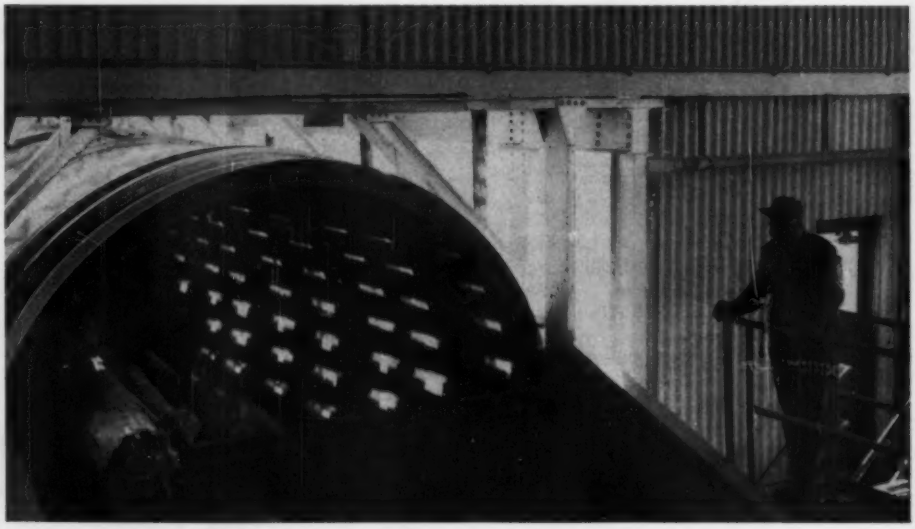
are of permanent, low-maintenance construction. Rail lines serving the area facilitate the delivery of pulpwood logs and process materials, and provide a means of shipping finished products to markets in several Western states. The rail loading area extends into the finishing building so that employees and finished products are sheltered from the weather.

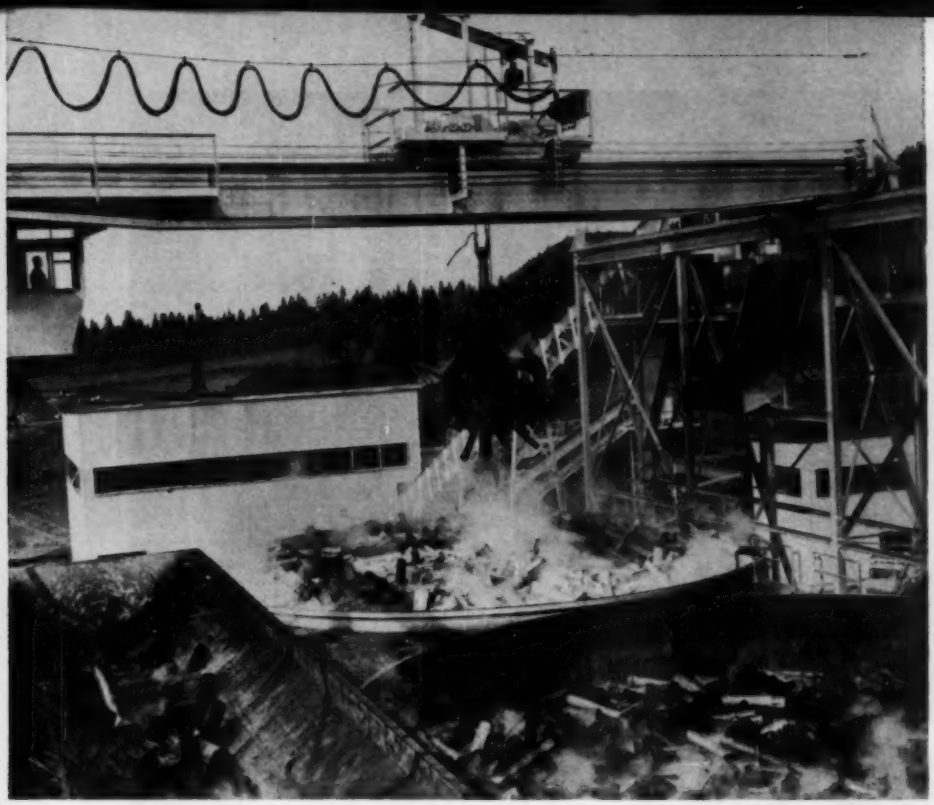
Materials handling was given particular attention in the design of the new facility. The handling system includes a large crane used to transfer pulpwood logs from an outdoor storage area to a conveyor at the input end of the manufacturing process. Throughout the plant, overhead cranes and conveyors transport the wood fiber with little or no manual assistance. Fork trucks handle the finished products in the packaging, warehousing, and storage areas of the plant.

Among the major pieces of processing equipment installed in the plant are two large grinders that reduce barked and chemically treated logs to pulp.

4

Bark is removed from the logs as they progress through this barking drum. The bark, and scrap from the sawing operation, are collected and conveyed to a shredder. Reclaimed, shredded material is then conveyed to the plant boiler house where it is burned as fuel.





5

Sawed and barked logs are conveyed to processing area where they are placed in soaking tanks by overhead, traveling crane. Logs are soaked for several hours in a mildly caustic solution at temperatures between 190 and 200 F. After soaking, logs are removed by the crane and transferred to a feed conveyor for a pair of grinders. The ground product is then mixed with water to form ground wood stock.

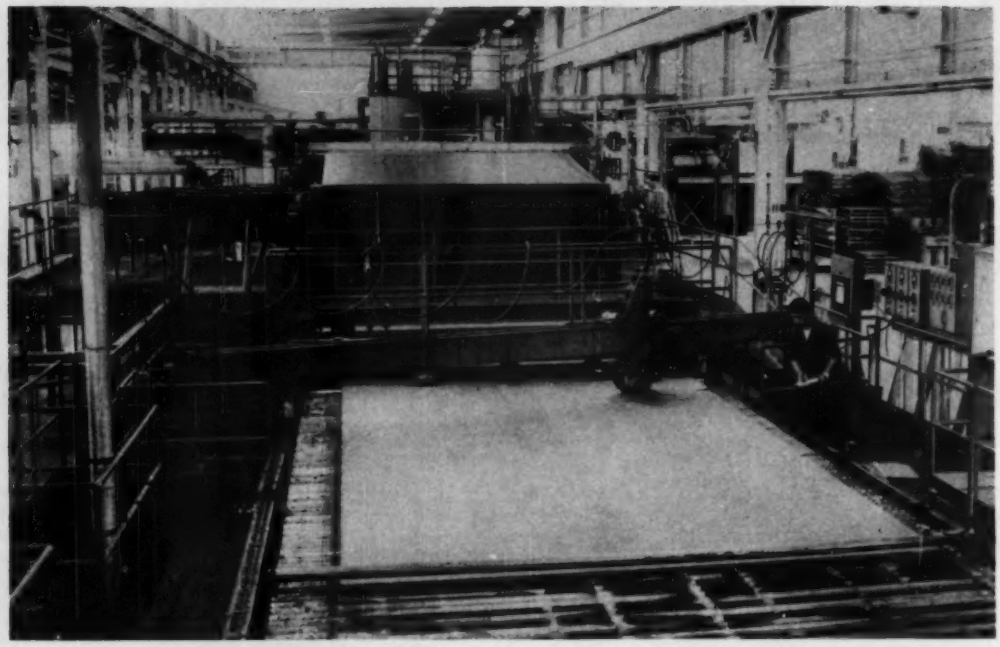
The wheel of each grinder is over 5½ feet in diameter, weighs 8 tons, and is driven by a 3000 horsepower motor. Other large equipment items include a board former that converts wet pulp into a continuous sheet up to 14 feet wide, and a drying oven that removes water from panels cut from the sheet. Connecting the pulp and finishing buildings, the oven has drying zones that total approximately 420 feet in length.

Water for the plant is supplied by two 750 gpm deep wells. Discharge water is dumped into an impounded settling area and then bled into a nearby river. To ensure proper control, the water is sampled and tested periodically.

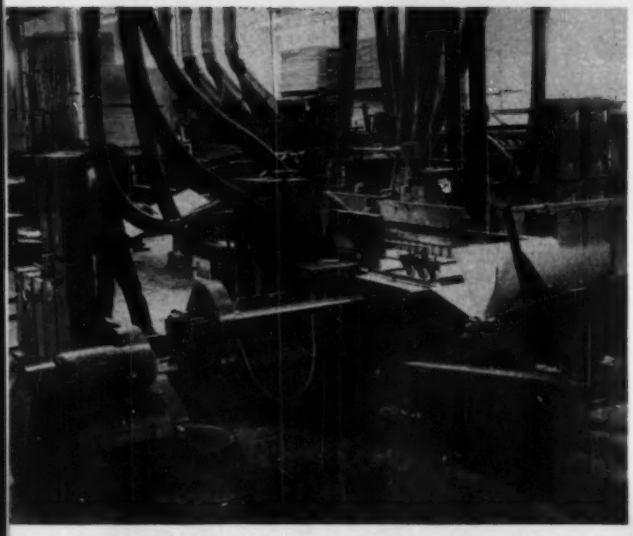
Special equipment collects the dust generated in the manufacturing process. Sawdust created by the cutting operation is conveyed to wet collectors and returned to the process. To prevent the escape of unburned bark and coal from the boiler exhausts into the atmosphere, fly ash collectors are used.

6

Deckers of type shown are used in the final step in the process of making pulp from ground wood stock. Following this operation, pulp is stored in stock chests to which may be added sizing and other ingredients.



7 View of output end of sheet forming system shows automatic saw that traverses and cuts continuous wet sheet of insulating board into panels up to 24-feet long. Equipment in background receives pulp from stock chests and converts it by forming and pressing operations into a continuous sheet up to 14-feet wide. Asphalt slurry may be added to the pulp to form impregnated board. Formed and cut panels are conveyed through a continuous drying oven connecting the pulp building with a finishing building.



8 Panel material is planed to uniform thickness, cut to approximate tile size, and special joints are machined in all four edges of each tile piece, in this ceiling tile finishing area. An efficient dust collection system removes process scrap and dust generated in planing, sawing, and tenoning operations. Ceiling tiles are packed and sealed in cases before shipment.

9 Finished insulating board products are loaded into railroad cars by fork lift trucks. Rail loading area extends inside the finishing building so that weather conditions do not affect loading operations. Wrapping stands and case sealing machines are spotted throughout the finishing building to prepare products such as those shown being loaded.

ASSEMBLING WASHER TUBS

ON COMBINATION FORMING AND WELDING LINE

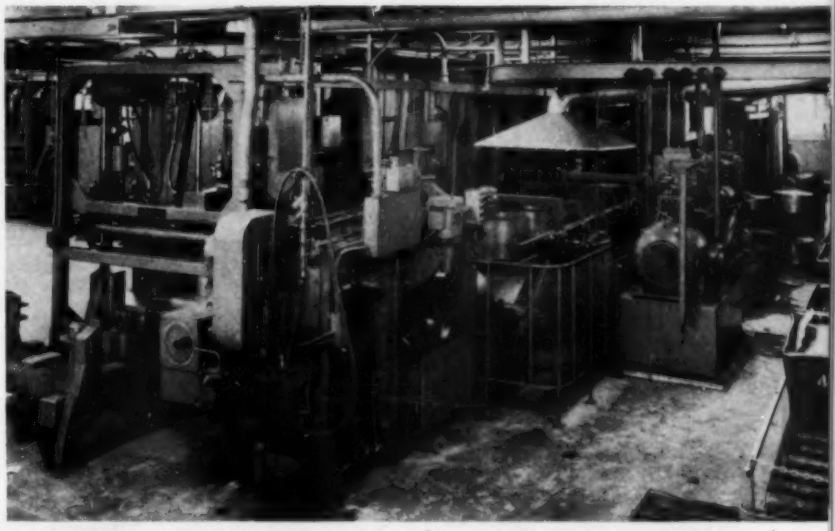
By **CHRIST REINING**, Works Engineer, Mansfield Plant, Westinghouse Electric Corp., Mansfield, Ohio

FABRICATION of sheet metal assemblies is frequently difficult because they are awkward to handle. Many conventional machines and methods are simply not feasible for high production rates on these difficult-to-handle parts. One of the areas in which Westinghouse Electric Corp. requires a high production facility for such parts is in the manufacture of outer tubs for their automatic washing machines. The requirement is met by using an integrated line of automated equipment, *Fig.* 1, supplied by Federal Machine and Welder Co.

This interlocked line of machines involves twenty-

Operation Sequence
Outer Tub Line

Station	Operation
1	Destack wrapper blanks
2	Form cylinder & seam weld tub wrapper
3	Tip up and rotate 120 degrees
4	Idle
5	Expand and form
6	Idle
7	Pierce
8	Idle
9	Projection weld baffle & deflector to wrapper
10	Spot weld tub back to wrapper
11	Idle
12	Seam weld tub back to wrapper
13	Idle
14	Turn over
15	Idle
16	Spot weld hub to tub back
17	Idle
18	Projection weld motor bracket & two hanger brackets to tub
19	Projection weld idler guide, damper bracket, & two hanger brackets to tub
20	Idle
21	Eject assembly



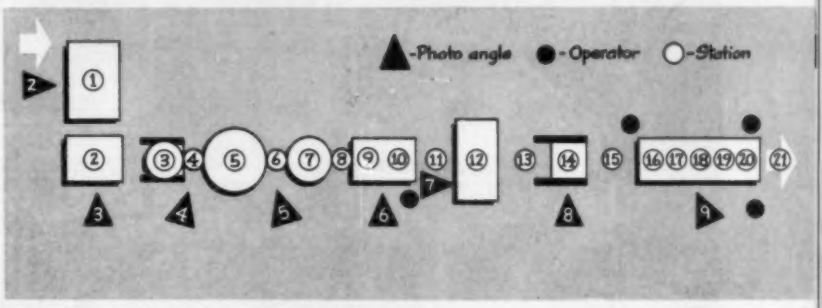


Fig. 1—Line of integrated machines produces welded outer tub assemblies for automatic washing machines. Blanks for tub wrappers are automatically fed and transferred through 21-station line. Completed assembly also includes 11 other parts which are welded in position.

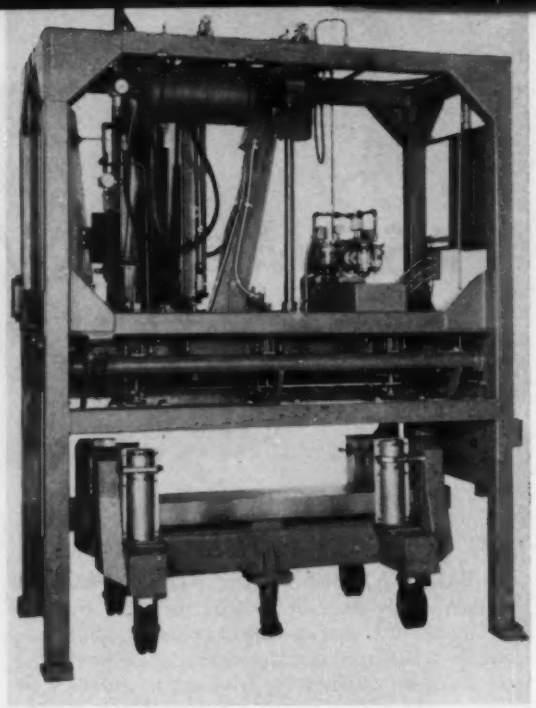


Fig. 2—First station on tub line receives stacks of blanks on 4-wheeled dollies. Destacker picks up top blank and feeds it into roll forming machine.

one stations and turns out an average of more than two complete assemblies per minute. Sheet blanks, required brackets, and other parts are brought to the line; finished outer tubs are ejected from the end of the line. Assembly of parts is accomplished by welding. Various stations seam weld, spot weld, and projection weld components in desired positions. Photographs in *Fig.* 2 through 9 show successive stations during construction of the line.

Sequencing of operation steps is performed by a static control system. The four operators on the line do not have to manually control the sequencing. However, they do manually place brackets and other parts on fixtures for welding to the tub wrapper. The wrapper itself is automatically transferred from station to station. The wrapper blank is fed into

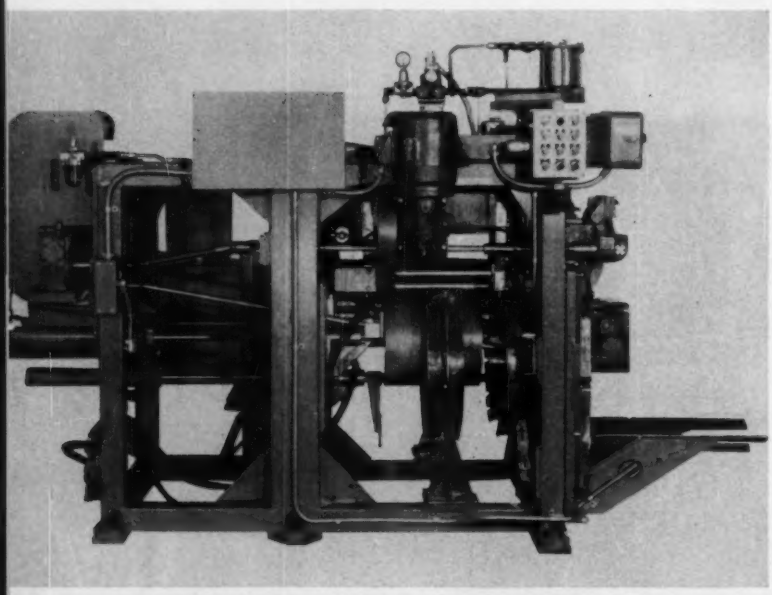
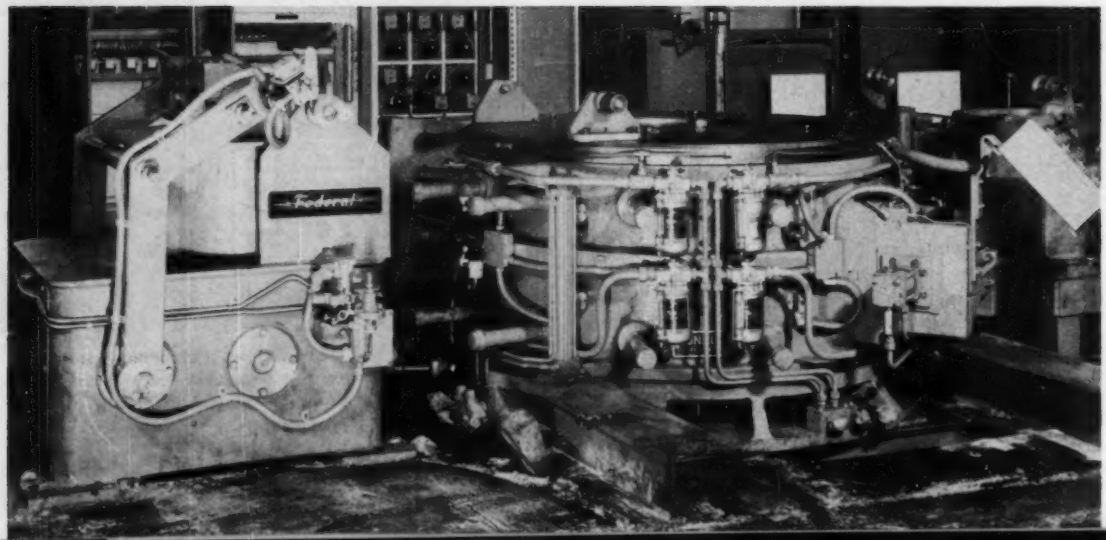


Fig. 3—Wrapper blanks feed into far side of roll forming operation and are seam welded. Cylindrical wrapper is pushed onto shelf at right.

Fig. 4—Welded wrapper is gripped by clamps on arms at left, swung up, and placed on rotating mandrel. Wrapper is rotated about 120 degrees in horizontal plane to give desired position of welded seam for subsequent operations. Reciprocating transfer mechanism (not in place for this picture) indexes cylindrical wrapper to hydraulic expanding machine. The cylinder is expanded to size; front and back flanges are formed; a sump is drawn to shape; and a hole is pierced opposite the sump.



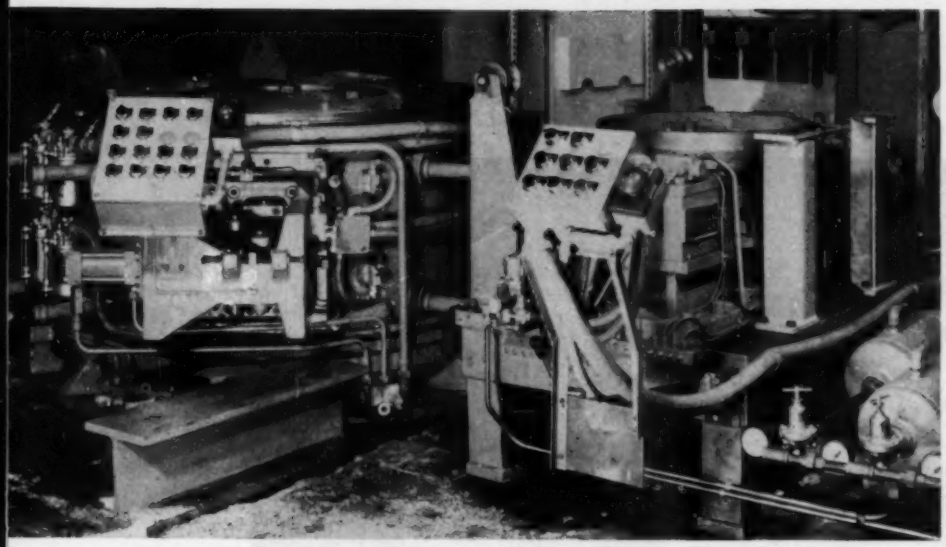


Fig. 5—Expanded wrapper is transferred to hydraulic piercing machine at right (transfer mechanism not shown). Three holes are pierced in the wrapper. A hydraulic load and ejector mechanism lowers the wrapper into position for piercing and elevates it to the transfer mechanism after the holes are pierced.

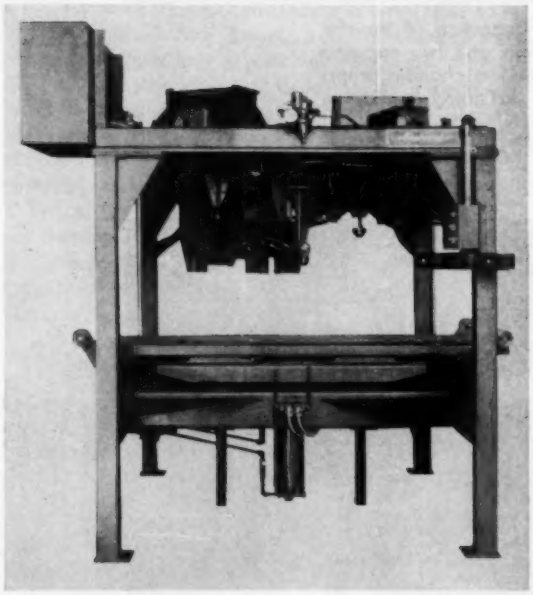


Fig. 6—Two-station welding machine receives wrappers from piercer. Wrappers are raised up to welding heads by cylinder under worktable. Station on left projection welds a baffle and a deflector plate to inside of tub wrapper. Station on right spot welds tub back to wrapper.

the forming rolls and seam welded at Station 2. A pair of swinging arms with clamps set the wrapper up on a rotating spindle at Station 3. The wrapper is then indexed on skid rails through the remaining stations by a reciprocating transfer mechanism.

For indexing, the wrappers are gripped between a pair of clamps or pins on the transfer bars. The bars then advance all wrappers one station; the clamps or pins are retracted; and the transfer bars return to their original positions. The construction views in *Fig.* 4, 5, 6, and 7 show equipment before the transfer mechanism was installed. Views in *Fig.* 8 and 9 show sections of the transfer mechanism in place.

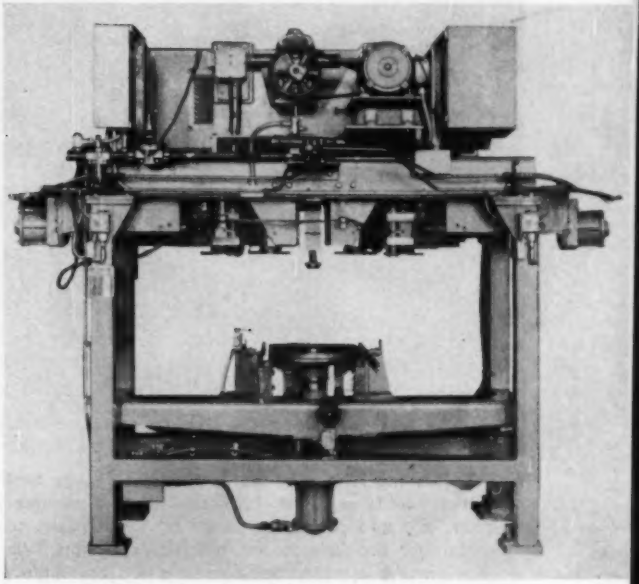


Fig. 7—View of inlet side of back seam welder was taken without transfer mechanism in place. Tub back is seam welded to tub wrapper, the assembly being rotated 180 degrees in the horizontal plane by the seam welding action.

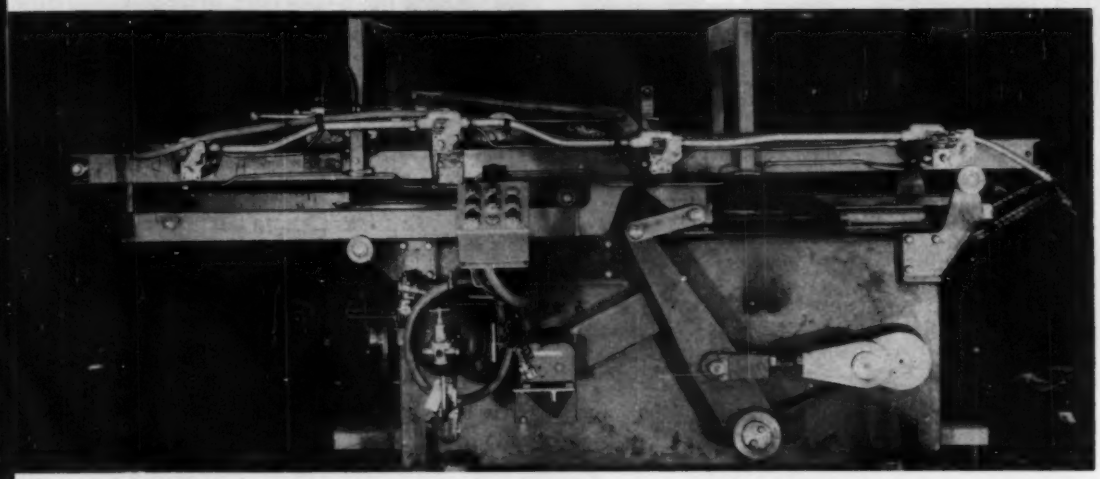


Fig. 8—Photo of turnover device at Station 14 also shows section of transfer mechanism. For turnover, the tub is lifted clear of skid rails and two opposed horizontal spindles move into two locating holes. The lifting mechanism drops; the spindles rotate 180 degrees in the vertical plane; and the lifting mechanism again rises to receive the tub and lower it to the skid rail.

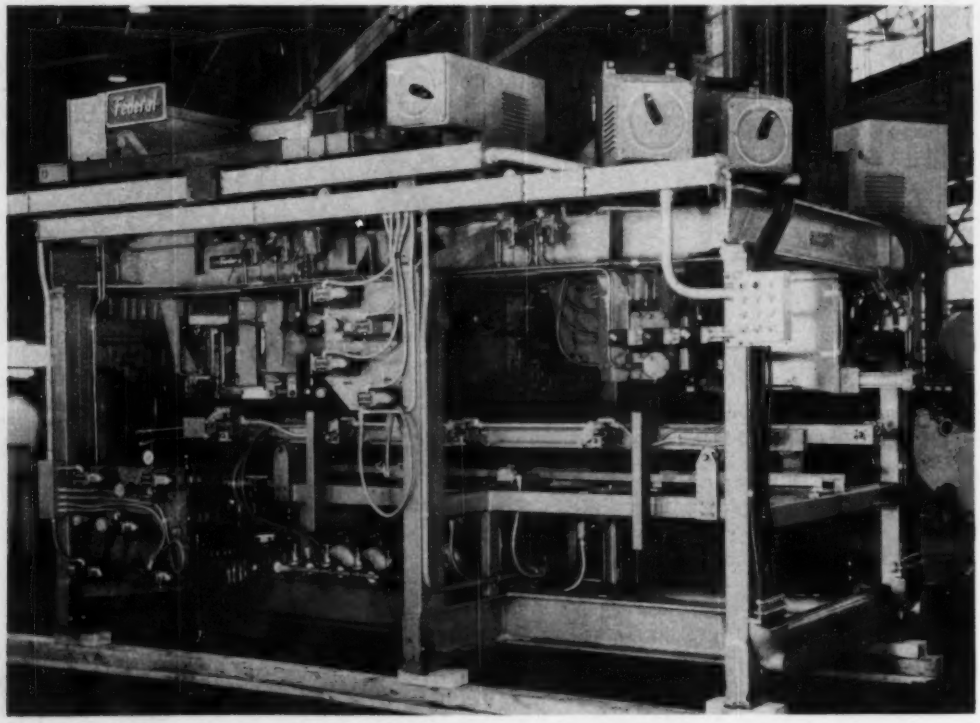


Fig. 9—This machine spot welds the hub flange to the tub back (Station 16); projection welds a motor bracket and two hanger brackets to the assembly (Station 18); and projection welds an idler guide, a damper bracket, and two more hanger brackets to the assembly (Station 19). A section of the transfer mechanism with opposed spindles to pick up workpieces is shown.

PUNCHED CARD FORMULATION OF POULTRY FEEDS

PRIME requirements for materials handling systems in modern feed mills are flexibility and efficiency of operation. With a great many standard and special purpose nutritive feeds in use, a feed mill typically may be called upon to prepare precisely formulated mixes from as many as 21 major ingredients. Batch sizes may range from a few bagfuls to several truckloads.

Both of these necessary qualities—flexibility and efficiency—are characteristics of a feed handling installation at the poultry feed mixing plant of Attala Co. Heart of the system is an automatic proportioning control setup manufactured by Richardson Scale Co.

Proportioning equipment includes a weigh hopper, a 5000-pound by 5-pound increment pedestal scale, an electrical control panel, and a punched card reader. In operation, a punched card containing all of the information needed to formulate a particular batch is placed in the card reader. If more than one batch of a given formula is required, the number (up to 100) is set on a batch stop counter on the control panel.

When the controls are actuated, feed screws at the bottoms of appropriate ingredient bins successively deliver ingredients to the weigh hopper. As each ingredient in the formula is weighed out, the feed screw for that ingredient stops and the next programmed ingredient is fed into the hopper. The cumulative weight is recorded on a dial on the face of the control panel. When the proper total weight is reached, the last feed screw is stopped automatically.

The contents of the weigh hopper are next emptied into a batch mixer where the feed is thoroughly mixed and liquid fat added if required. When mixing is completed, the batch mixer automatically discharges the feed onto a conveyor that transports the batch to bulk storage bins or to a bagging area. If the same formula is to be repeated, the original punched card is left in the reader; otherwise, it is replaced by a card corresponding to the next formula to be processed.

To protect the equipment and ensure accuracy of formulation, safety interlocks shut down the system if any component does not function properly. Additional controls regulate weight tolerances, liquid fat injection, and weigh hopper discharge.

The automatic feed handling system has shown several advantages over previous methods: Use of punched card programming eliminates mixing errors; material waste is reduced to minimum levels; the quick changeover feature of the system increases plant activity; and fewer manhours are required for the same output.

Control center for feed handling system contains electrical panel, punched card reader, and weighing scale. System automatically formulates poultry feeds, at a rate of 25 tons per hour, from a selection of up to 21 ingredients stored in bins. Finished, mixed batches are deposited on a conveyor leading to bagging and storage areas.

Card reader accepts an individual punched card containing separate programming information for each feed mix produced. Multiple batches of a given formula may be programmed without removing card from reader.

PROGRAMMED NAILING CONTROLLED BY SWITCHES AND CAMS

Pacing industry's requirements, improvements in nailing machines are carving out new fields for this type of production equipment. Programming controls and modular construction are part of the new look in current models.

By **JOHN R. RICHARDS,** Project Engineer, Packing Equip. Div., Food Machinery & Chemical Corp., Riverside, Calif.

EVOLUTION of nailing machines has progressed to a point where these devices may be regarded as integrated production systems rather than individual equipment items. Unlike early models which did little more than drive nails, present machines combine key features of handling, work performing, and control. For example, nail pattern programming, clinching, work indexing, and ejection of finished products are now combined, in some machines, with the basic operation of nail driving. Flexibility of operation inherent in these machines permits the automatic assembly of a variety of products.

Changing Climate

The trend toward automation of nailing machines was accelerated by economic and technical forces. Before World War II, the primary use of nailing machines was in the fabrication of wooden boxes for shipping fresh fruits and vegetables. Machines

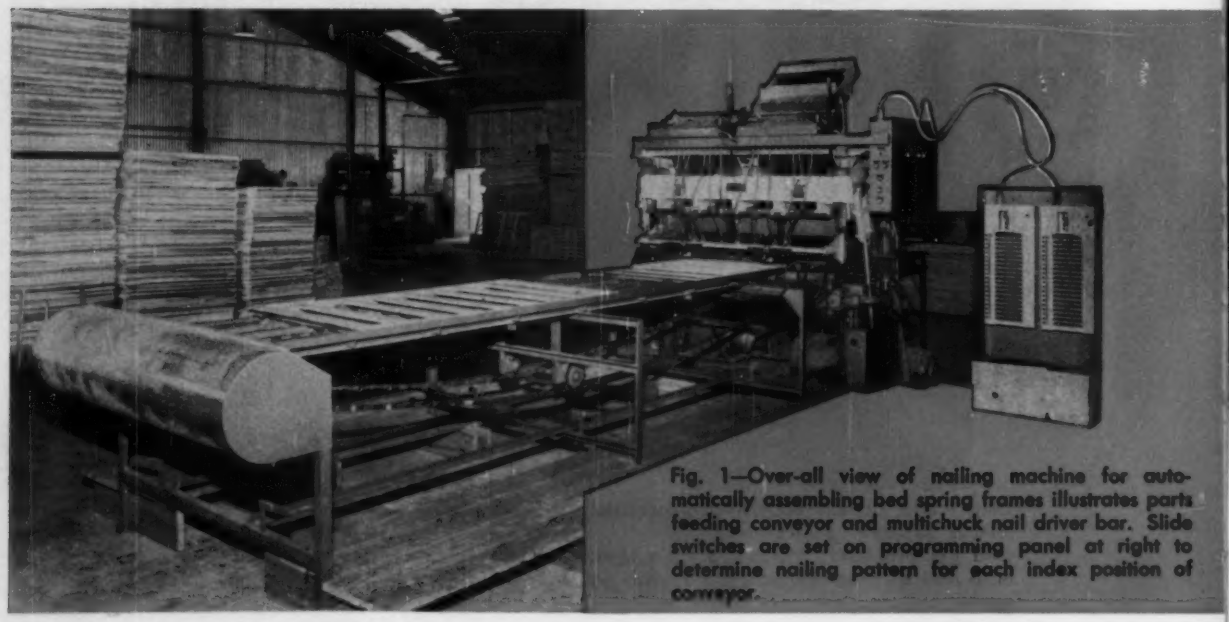


Fig. 1—Over-all view of nailing machine for automatically assembling bed spring frames illustrates parts feeding conveyor and multichuck nail driver bar. Slide switches are set on programming panel at right to determine nailing pattern for each index position of conveyor.

for this application were well developed, with the shook (wooden parts and subassemblies) being fed automatically in some cases. However, little attention was given to automating other phases of the over-all operation. The war was to change this by causing a shortage of semiskilled workers and a consequent steep rise in labor rates for this type of personnel.

Also, about this time, cardboard and wire bound boxes began to supplant nailed wooden boxes. Thus, a diminishing market for the product threatened extinction of the nailing machine industry. Obviously, the development of new markets and more efficient machines were indicated.

New markets were found in several industrial areas. The material handling field required millions of wooden pallets. Many other nailed products—large crates and boxes, bed spring frames, panels, and prefabricated wall sections—were in great demand. Competition among manufacturers of these items was keen, and they were interested in making better, less expensive products.

Development Program

Personnel of the Packing Equipment Div., Food Machinery & Chemical Corp., who had designed box nailing equipment, recognized the need and challenge of developing these new markets. Thus, in 1946, a program was established to develop a line of nailing machines suitable for these applications.

The major program objective was to develop a series of basic machine units that could be combined into automatic systems for assembling various nailed products. Since each manufacturer and product had different requirements, each nailing system would have to be custom designed. Availability of basic modules, therefore, would permit construction of machines to do these various specialized jobs at low cost and with short lead times. As a commentary on the success of the program, systems based on this principle are in operation assembling products as diverse as redwood patio furniture, cooling tower parts, wooden pallets, and bed spring frames.

An example of the type of nailing machine system that evolved from the FMC development program is a bed spring frame assembly machine, *Fig.* 1, installed in the Houston, Tex., plant of Globe Box Co. This machine is typical of those used by box spring manufacturers throughout the country, except for modifications occasioned by unique conditions and individual application requirements.

Bed spring frame assemblies usually are made in a variety of sizes. Essentially, each frame consists

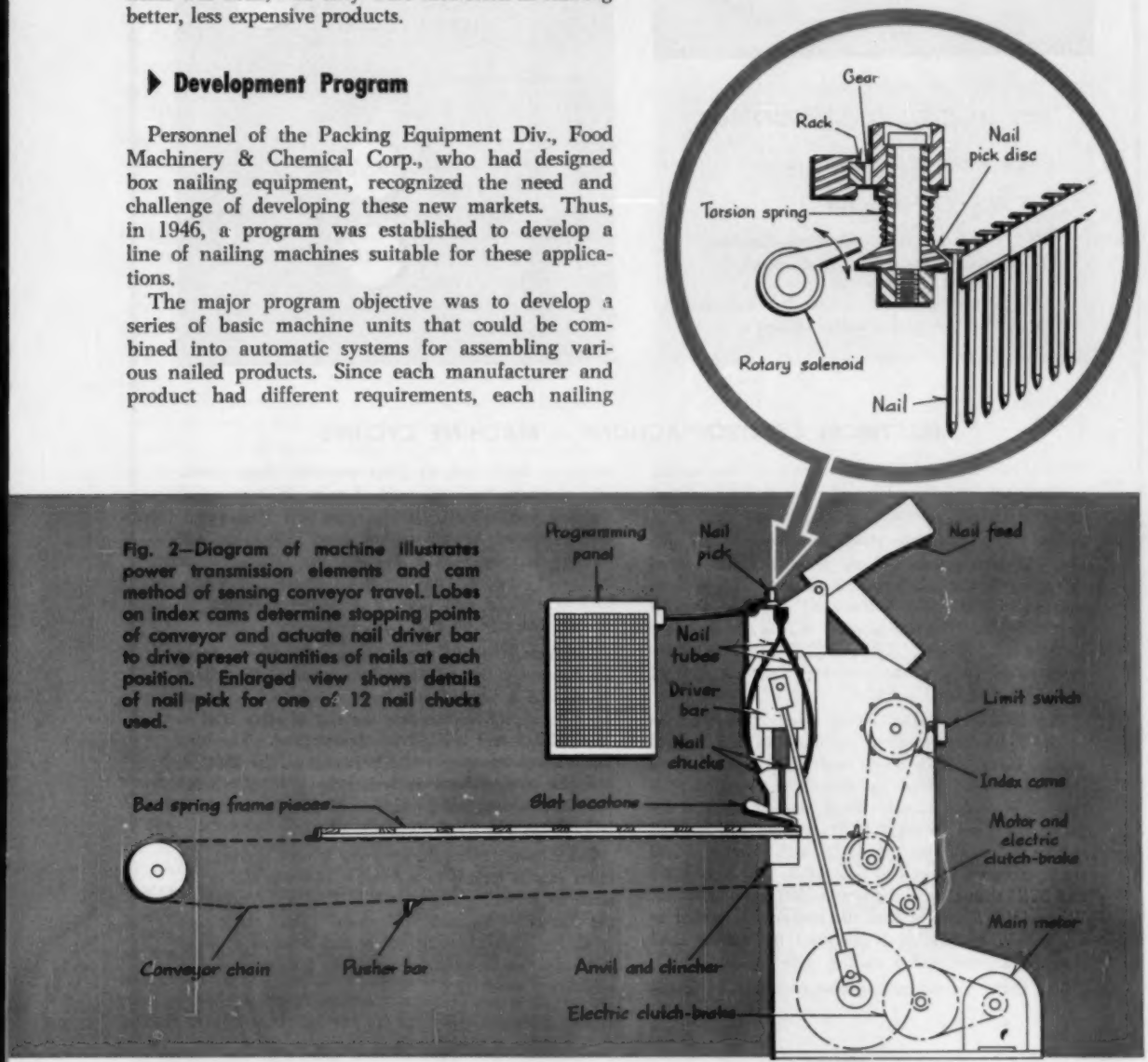
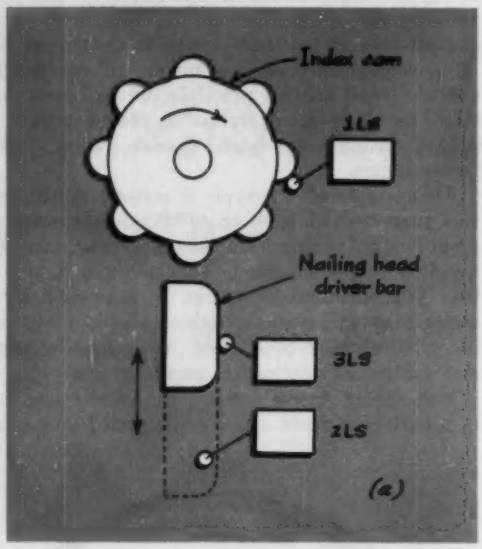


Fig. 2—Diagram of machine illustrates power transmission elements and cam method of sensing conveyor travel. Lobes on index cams determine stopping points of conveyor and actuate nail driver bar to drive preset quantities of nails at each position. Enlarged view shows details of nail pick for one of 12 nail chucks used.



KEY TO CIRCUIT COMPONENTS

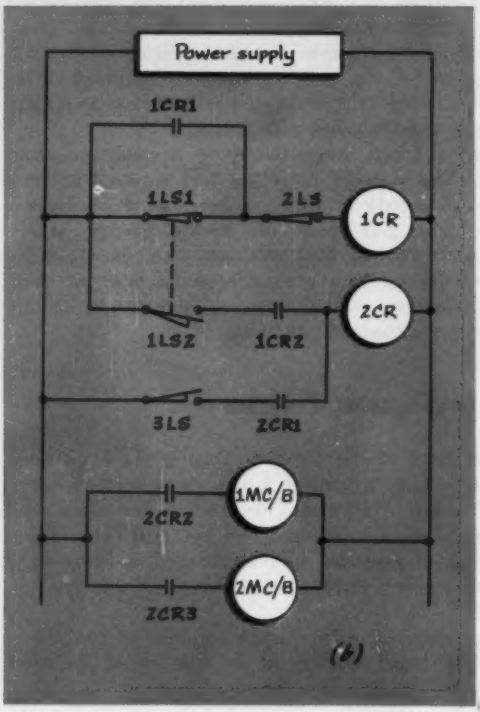
1LS, 2LS, 3LS - Limit switches

1CR, 2CR - Control relays

1MC/B - Conveyor clutch-brake control (brake engaged when energized)

2MC/B - Nailing head clutch-brake control (clutch engaged when energized)

Fig. 3—Mechanical diagram *(a)* shows relative positions of machine cycling limit switches and their manner of actuation by machine elements. Electrical diagram *(b)* illustrates circuit that synchronizes indexing of conveyor and actuation of nailing head.



ELECTRICAL CONTROL ACTIONS — MACHINE CYCLING

STEPS in the operation and control of the nailing machine can be followed by reference to the mechanical and electrical diagrams of *Fig.* 3*a* and *b*.

Feed Parts. With the index cam in a position such that 1*LS* is not actuated, and with the nailing head driver bar in the raised position allowing 2*LS* to close, the coil of relay 1*CR* is energized and held through contact 1*CR*1. The coil of relay 2*CR* is not energized because 1*LS*2 is open. Thus, 1*MC/B* and 2*MC/B* are de-energized so that the conveyor clutch is engaged and the nailing head is braked.

Stop Conveyor, Begin Nailing Cycle. When a lobe of the index cam contacts and operates 1*LS*, several actions occur. 1*LS*1 opens and 1*LS*2 closes. Since the nailing head driver bar is still in its raised position, 2*LS* remains closed. Thus, the coil of 1*CR* remains energized through 1*CR*1 holding contact and switch 2*LS*. Closing of 1*LS*2 with contact 1*CR*2 closed energizes the coil of relay 2*CR*. Contacts 2*CR*2 and 2*CR*3 then close and energize 1*MC/B* and 2*MC/B*. When 1*MC/B* is energized the conveyor is braked to a stop. When 2*MC/B* is energized the nailing head clutch is engaged and a nailing cycle begins.

Nail Parts. As the nailing head completes its downstroke to drive nails into the assembly, limit switch 3*LS* closes to hold the coil of relay 2*CR* energized through contact 2*CR*1. At the same time, limit switch 2*LS* is opened by the nailing head driver bar and the coil of relay 1*CR* is de-energized. The conveyor is braked and the nailing head actuated, however, because 1*MC/B* and 2*MC/B* are held energized by closed contacts 2*CR*2 and 2*CR*3.

Complete Nailing Cycle. As the nailing head driver bar returns to its raised position after nailing, limit switch 3*LS* is opened and limit switch 2*LS* is closed. Opening of 3*LS* de-energizes the coil of relay 2*CR* so that 1*MC/B* and 2*MC/B* are de-energized. The conveyor starts because its clutch is engaged by 1*MC/B*, and the nailing head is braked by 2*MC/B*. Relay 1*CR* is not energized by closing of 2*LS* because 1*LS*1 is held open by the index cam lobe.

Index Parts. Since the conveyor is now moving, the index cam is rotated to a position allowing 1*LS* to assume its normal position with 1*LS*1 closed (energizing the coil of 1*CR*), and 1*LS*2 open. Thus, the circuit is in its original configuration and remains so until the index cam rotates the next cam lobe into contact with limit switch 1*LS*.

of a nailed and clinched wooden structure which includes a pair of longitudinal rails to which slats are assembled transversely at predetermined, spaced intervals. Under each end slat is a support member, and these elements are nailed along their entire lengths. Intermediate slats, requiring no support members, receive nails only at their ends.

Automatic Operations

Two basic operations are performed automatically by the machine: Conveying and nailing. Conveying is accomplished by an endless chain arrangement which carries pusher bars at predetermined, spaced intervals. In the model shown, the pusher bars are spaced 8-feet apart. In operation, pieces of the frame are laid in the conveyor with the rails in guides and the slats in their approximate positions on top of the rails. A pusher bar on the endless chain engages the rear of each wood piece assembly, indexes the parts beneath the nail-driving bar, and ejects the finished frame assembly to a discharge point. The equipment has provision for feeding up to 24 nails at a time across the width of the frame.

Other mechanisms and controls position the slats relative to the rails, square the end pieces, and determine the number of nails to be driven in each wooden member.

As illustrated in *Fig.* 2, nails are fed by an oscillating hopper into multiple tracks or runs. At the end of each track is a notched disc, or nail pick, into which the shank of the leading nail fits. In a nail driving cycle, the disc is rotated mechanically during the stroke of the driver bar. Rotation of the disc picks up the leading nail in the track and deposits it in a tube leading to the nail chuck.

If, in a given nailing cycle, a particular chuck is not to receive a nail, the disc rotation is stopped and a nail is not dropped. This action is accomplished by a rotary solenoid-operated finger that engages a notch in the disc and prevents its rotation. A torsion spring in the nail pick assembly absorbs the mechanical turning force tending to rotate the disc.

The conveyor is driven by a main motor through an electric clutch-brake. The speed of the conveyor is 25 fpm. A bank of nine index cams is driven on a common shaft in synchronism with the conveyor motion. The drive ratio between the conveyor shaft and the cam shaft is such that one revolution of the cam shaft corresponds to the linear distance between pusher bars on the conveyor. Thus, rotation of the cam shaft corresponds to distance along the conveyor.

Each index cam is in the form of a circular disc having a groove around its circumference. Small nuts may be inserted in the groove, and round head machine screws may be fastened to the nuts from the outside of the disc. The heads of the screws, projecting radially from the disc, form elementary cam lobes. These may be positioned and locked in place anywhere on the periphery of the cam disc.

The function of the index cams is to stop the conveyor at the proper place, actuate a nail driving cycle, and start the conveyor to index bed spring frame parts to the next nailing position. Each cam (corresponding to a frame model) can be preset

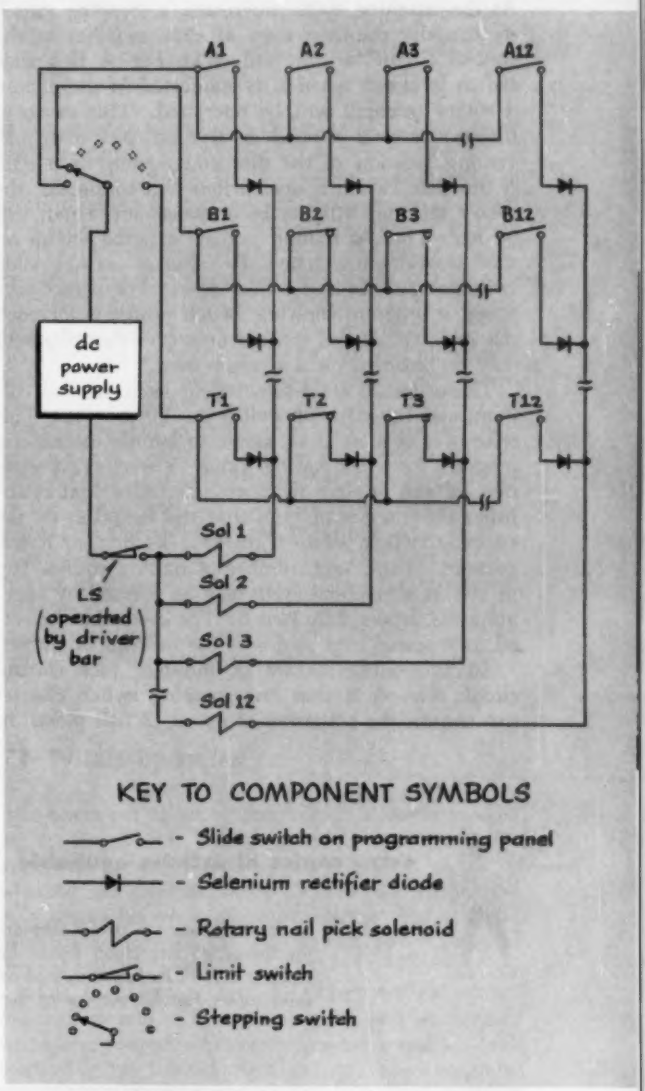


Fig. 4—Partial circuit diagram of programming controls illustrates manner of setting slide switches to obtain different nailing patterns. At a given index position of the conveyor, corresponding to a step position on the stepping switch, a row of slide switches (such as A1, A2, A3, etc.) is connected in the control circuit. Rotary solenoids corresponding to each slide switch are actuated if their switches are closed. When a solenoid is actuated, a nail will not be dropped to a nail chuck. As frame parts are indexed beneath the nail driver bar, the stepping switch is advanced to connect other rows of slide switches in the circuit. Thus, a different nailing pattern may be set up for each stopping point of the conveyor.

for a different nail spacing, which is reflected in the frame as a slat spacing. Control actions occurring as a result of rotation of one index cam are described in the box accompanying the mechanical and electrical diagrams of *Fig.* 3.

Programming Controls

As explained previously, the end slats and support members for a frame each receive nails across their entire lengths, while intermediate slats are nailed only at their ends. Establishing this nail pattern is accomplished by actuating a series of switches on a programming panel.

The panel contains 24 vertical columns of 20 slide switches. Each column corresponds to a nail pick. As the machine cycle progresses, a stepping switch sequentially connects rows of slide switches to the control circuit for the nail picks, *Fig.* 4. If a slide switch is closed when it is connected in the circuit, a rotary solenoid will be energized. This causes a finger to engage a notch in the nail pick disc, preventing rotation of the disc and feeding of a nail. If the slide switch is open when it is connected, the rotary solenoid will not be operated and a nail will be fed. Thus, a nailing pattern may be set up on the programming panel by closing certain slide switches and leaving others open. For setup purposes, a program showing switch positions for each size and type of bed spring frame (or other product) may be recorded on a separate card.

There are 20 slide switches in each vertical column, and the stepping switch has 20 contacts. This selectivity is more than ample to handle the nailing program for a bed spring frame. Therefore, a separate column of slide switches is provided that establishes the number of steps that will be taken by the stepping switch before it resets to its first, or home, position. Thus, any number of nailing strokes (up to 20) in a machine cycle may be selected by operating the proper slide switch. The cycle, once selected, is repeated over and over for subsequent frames.

An interesting feature of the nail pick control circuit, *Fig.* 4, is that one stepping switch contact can control the actuation of up to 12 nail picks. In nailing intermediate slats, for example, when it is desired to nail only at the ends, many of the slide switches in a row are closed. Multiple solenoids are then actuated through a stepping switch contact for an intermediate slide switch row position. This holds back the feeding of nails from the preselected nail tubes.

Operation of several solenoids through one stepping switch contact was made possible by the use of direct current for the solenoid power source and by placing silicon rectifier diodes in each slide switch circuit, *Fig.* 4. Since the diodes conduct current in only one direction, cross-effects between solenoids are prevented. A considerable savings in wiring was thus realized over what would have been involved if separate banks of the stepping switch had been used for each solenoid. The chance for wiring errors was also reduced.

Another feature of the stepping switch circuit is that solenoid current is broken by a limit switch, and not a step contact. This is an important consideration in using stepping switches, since failure to include such a provision can affect switch life adversely. Properly applied, as in this instance, these telephone-type components are capable of reliable, continuous industrial service.

Wide Applicability

The short setup time possible with a programming panel makes an automatic nailing machine practical for short runs of a variety of products. Up to 24 nails from 4d to 10d can be driven with a crank type machine; a hydraulic machine can drive 20d nails into hardwood.

Often, a design change in the product can be justified in order to best suit it to machine nailing, since the savings may be considerable. It is reasonable to expect production per manhour to increase by eight or ten times over conventional nailing methods. In addition, the product is usually better; the pieces are clamped tightly when they are nailed and tend to stay tight in assembly. The part is also held to proper dimensions and squareness. All of these advantages have caused a trend to nailing machines which is continuing. Some manufacturers are just discovering these machines; others are returning to the use of wood in their products. The future will see automatic nailing machines in use on products which do not now exist.

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Fig. 1—Cutaway view of lead-acid storage battery illustrates grid structure of negative and positive plates. Weight of active material in each plate must be controlled rigidly to ensure uniform, high performance. Batteries are used for industrial control, communications, and vehicular applications.

RADIATION GAGE REGULATES PASTE DISPENSING

By GEORGE N. STOVER
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PLATE PASTING represents one of the more critical operations in the manufacture of storage batteries. As storehouses of potential power, the finished plates must be uniform in thickness and weight to ensure precise electrical characteristics and capacity in assembled cells. The uniformity of these cells, in turn, affects the performance of the complete batteries of which the cells are subunits.

Cast lead-antimony and lead-calcium grids serve as latticework supports for the blend of lead oxides, or active materials, in positive and negative plates, *Fig.* 1. The active material, in the form of a paste, is applied to the grids during manufacture.

In the previous procedure at C & D Batteries, paste was applied to the grids by manually controlling the operation of a pasting machine. To ensure uniform paste thickness, time-consuming quality control methods were used which involved the weighing of sample plates during manufacture and averaging of the test results. This method, of course, was relatively slow and costly. In addition, the ever-present possibility of human error had to be contended with.

Addition of an automatic control system to the plate pasting machine, *Fig.* 2, has improved the pasting operation considerably. The system accurately measures the weight of active material applied to the plates and automatically adjusts the machine to maintain a uniform, preset quantity for all plates of a given type.

Automatic Weight Control

Heart of the control system is a radiation-type gaging head designed and built by Industrial Nucleonics Corp. Basically, the gaging head employs beta and gamma radiation from disintegrating radioactive isotopes to measure the mass of material passing the head.

In a given time, for a specific radioisotope, a given number of high-energy electrons is given off by the source. This stream of electrons is focused and passed through the plates. Depending upon the thickness and composition (or mass) of the plate material, some of the electrons are absorbed by the material. Measurement of the remainder of the electrons—those which pass through the plates and reach a radiation detector on the other side—forms a basis for weight control.

Actual weight determinations are made by comparing the amount of radiation passing through the material with the amount received with no material in the measuring gap. The resulting signals generated by the detector are amplified and applied to a recorder and a control unit. The recorder provides a permanent chart record of weight per unit plate area. The control unit processes the weight information and actuates a roll pressure adjusting mechanism that holds the pasting rate within close limits.

System Operation

In operation of the system, *Fig.* 3, grids are stacked at the input end of the machine and fed automatically to a belt conveyor. The belt conveyor advances the grids, in single file, between application rolls associated with the paste supply hopper. Roll pressure determines the amount of active material pressed into the grids.

After they are pasted, the plates are passed between two sets of smoothing rolls and are gaged. In gaging, source radiation is directed across a 3-inch measuring gap toward the detector. When measurements are taken (every fifth of a second with a plate

in the gap), the detector is reciprocated back and forth to scan the entire plate width.

Radiation passing through a plate and entering the detector chamber generates a high dc voltage in this element. The voltage is an analog of the weight of paste per unit area of plate. As long as the weight is constant, the voltage remains constant. If weight varies, the voltage varies accordingly. Signals thus generated in the detector are transformed to a usable form and amplified.

The ouput of the amplifier, indicative of weight of paste per unit plate area, is fed to the control unit. Here, the amplifier signal is compared with a set point signal representing desired weight. If a difference exists between these two signals, the control unit activates the roll pressure adjusting mechanism to effect a correction. The recorder also receives amplifier output signals and plots the results of gage measurements taken throughout a run.

Plates which have been gaged are passed to a conveyor consisting of two parallel chains. As the plates are picked up by the chain conveyor, they swing to a vertical position. Support is by tabs at the leading ends of the plates.

▶ Safety and Self-Checking Actions

The automatic control system contains several safety interlock and self-checking provisions. For example, if upsets occur that place operation outside the automatic control range, an alarm rings to signal the operator to switch over to manual control. Excessive corrective action, and false corrections due to power failures or mechanical binding of the recorder pen, are also prevented by safety interlocks.

If, on startup or because of a jam, an off-standard plate is produced, an alarm will signal the operator and the defective plate will be rejected. A line footage counter prevents repeat corrections until the system has observed the effect of its previous correction.

Every half-hour, the measuring unit withdraws automatically from the line and standardizes itself for accuracy. If the system is unable to measure accurately, it shuts down automatically.

Nine months of operational experience with the plate pasting machine under automatic control have proved the feasibility of this technique and revealed its advantages over manual control:

1. Plate uniformity has been improved substantially. With automatic control, variations in weight of paste per unit area of plate can be held within ±1 per cent of nominal.

2. The need for weighing sample plates and calculating averages has been eliminated. Inspection is performed automatically on 100 per cent of the products.

3. The operator is no longer required to adjust the machine continually to maintain a uniform flow of paste onto the battery plates. Consequently, he has more time to devote to other functions.

4. Weight variations due to periodic introduction of fresh batches of paste into the machine supply hopper have been eliminated.

5. The automatic control system returns the process to target, following a jam or upset, far more rapidly and accurately than was possible with manual control.

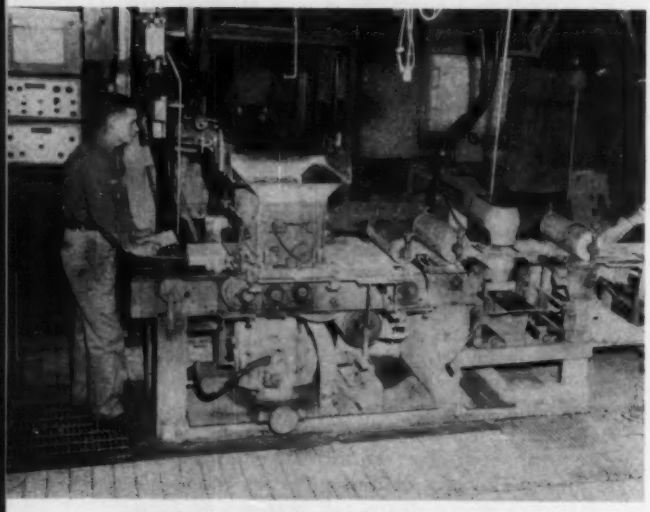


Fig. 2—Plate pasting machine fills cast lead alloy grids with active material to form battery plates. Radiation gage, right, monitors weight of paste applied and actuates automatic controls that adjust machine to maintain preset weight. Chart recorder, left background, provides permanent record of gage measurements.

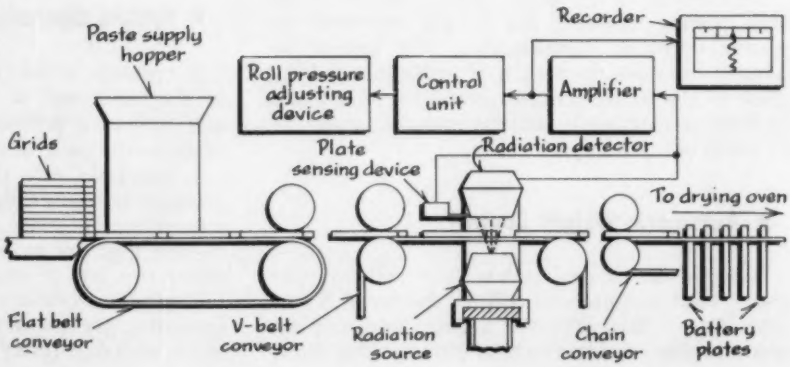
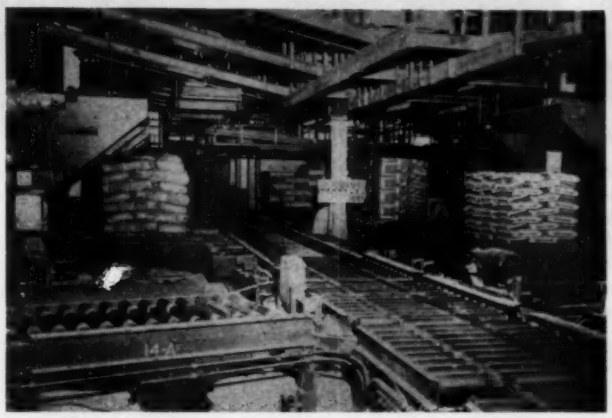


Fig. 3—Simplified diagram illustrates major machine and control elements used in plate pasting installation. Set-up for automatic operation is made with acceptable plate placed in gaging position.

Exemplifying extremes in warehousing, pictures contrast simple manual system in pharmaceutical warehouse and complex automatic system in refined sugar warehouse. In simple system, right, roller conveyors carry individual baskets past storage racks. Desired items are picked from racks and placed in baskets after which the baskets are conveyed to packing area. In illustrated complex system, various sized packages of sugar are automatically directed to palletizers over complex conveyor network. After the pallet loads have been formed, the loads are indexed onto central conveyor and directed to one of several areas within the warehouse. The complete operation of the warehouse is automatic.



A companion article to "Automatic Warehousing — The Concept" (See Automation, Nov., 1959), this discussion is concerned with methods and equipment that are available today to upgrade warehouse operations. The variety of equipment ensures that a systems designer can obtain that degree of automation that best benefits a particular case.

AUTOMATIC WAREHOUSING —THE MEANS

By **H. C. KELLER**, Vice President, Lamson Corp., Syracuse, N. Y.

THE PRIMARY GOAL in warehousing does not differ in essence from the goal of other operations in industry—the operator or manager is interested in obtaining the most economical and efficient operation. In some warehousing operations this goal can be achieved with a relatively small investment in equipment. In other cases, the goal can be attained only with a sophisticated system that calls for a sizable investment in equipment. The important thing to note is that equipment is available today to satisfy virtually any desired degree of automation, including means of completely integrating the paperwork phase (inventory control, bills of lading, invoices, etc.) with the movement of goods.

Increasingly, industry has come to realize that ware-

Automatic equipment should be included in warehouses only when it is justified. Illustrated manual operation being performed on individual packages is that of sorting. In an otherwise automatic system, operator separates packages, positioning the different types on the roller conveyors such that they drop off at desired points connecting with belt conveyors leading to particular areas. In other illustration, automatic switch connects large roller conveyor trunk lines over which heavy pallet loads of various types of a product are to be carrried to different destinations.

housing is something more than just piling goods in a large building. It is an important adjunct to the manufacturing process and, as a money consuming function, warehousing includes parameters that can be studied and manipulated to obtain an efficient operation. The purpose of this article is to examine the various phases of warehousing—receiving, directing to storage, storing, withdrawing from storage —in light of methods and equipment that are presently used to obtain desired efficiencies. The discussion will be limited to the movement of goods that are adaptable to handling by conveyors, i.e. cartons, boxes, bags, drums, etc., that can be generally classified as "packages."

▸ Receiving

From the warehousing viewpoint, packages may be received as individual units from nearby manufacturing areas or in large lots from remote manufacturing areas. In the first case, the packages usually arrive at the warehouse in single file on a conveyor line. Large lot shipments are typically received on pallets or in "cubes" (assemblies of packages into unit loads that can be easily transported). The general problem of automatic warehousing at this receiving stage is determined by the intended technique of storage within the warehouse.

Where packages are to be stored as units on live conveyor lines, the individually received packages on conveyors can be directed to the storage conveyor lines or bulk storage areas. Packages that have been received on pallets or in cubes must be separated at the receiving point. Handling equipment manufacturers have developed automatic pallet unloaders to dismantle pallet loads and place individual packages in single file on a conveyor line.

Where packages are to be stored in pallet loads, those received in palletized form can be directed to live conveyor lines capable of handling complete pallet loads. Individual packages received direct from the production line must first be placed onto pallets before storage.

Various types of pallet loaders are available. Completely automatic loaders can place packages onto pallets in a desired pattern. Loaders are available that can palletize the production from several production lines, the number of lines depending on the rate of production. Where production rates do not justify automatic equipment, pallet loaders requiring the presence of an operator are available. For these types of loaders, the function of arranging packages into patterns can be made a manual operation.

▸ Directing to Storage

The method of storing determines equipment requirements in receiving operations and also, obviously, affects requirements in directing packages to storage. The complicating factors in this phase of warehousing are the variety of classifications of packages to be stored and the time relationship of the receipts of the various classifications at the warehouse.

If large lots of similar packages are received and are to be directed to a given location, the dispatching

lends itself to manual selection of locations. Identification in such cases is simplified since a single identifying code is used to identify a lot containing many individual packages.

Where it is necessary to examine each package, as when packages are received in mixed lots, they can be identified either manually or automatically. With some classifications of packages it is feasible to route individual units directly to storage locations. Automatic systems provide for sensing the identification code, spacing out succeeding units in a conveyor, and diverting the package at a desired point in the system.

In other cases it is more practical to have an accumulation area between the receiving and storage areas. Such an arrangement permits individual packages to be identified and directed to an accumulator station where like packages can be gathered into lots. The accumulators are conveyor lines that discharge into a common conveyor line leading to the storage area. In operation, packages are fed into the accumulating lines and then in a programmed sequence, the accumulating lines deliver their groups of packages to the common line. The discharge of lines is controlled electrically to prevent two lines discharging simultaneously, causing interference or mixing of packages on the common line. As an additional control technique, each line starting to discharge its lot of packages can register on a memory system which in turn creates signals that actuate diverters or deflectors at a time coinciding with the arrival of the lot at the proper storage point.

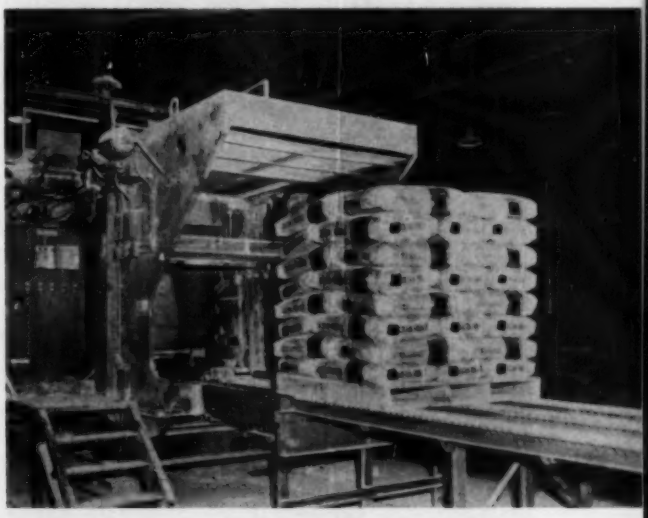
Memory systems for these applications can be developed around magnetic tape, punched tape, or any mechanical device synchronized with the conveying system such that a pin, lever, or other element operates an electrical circuit at the instant a deflecting point is reached.

Multistory warehouses present no problem in these automatic operations. The well publicized inefficiencies of multistory buildings have been overcome by modern equipment. For instance, shipping carriers are elevated or lowered to a convenient level for loading or unloading, thus eliminating the vertical handling of individual packages. Loads are automatically conveyed vertically to the proper floor after having passed a control point where an operator manipulates controls to designate a desired storage area.

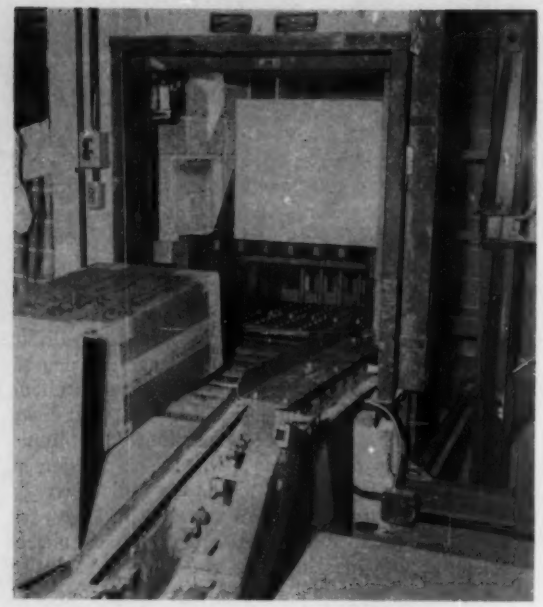
▶ Storing

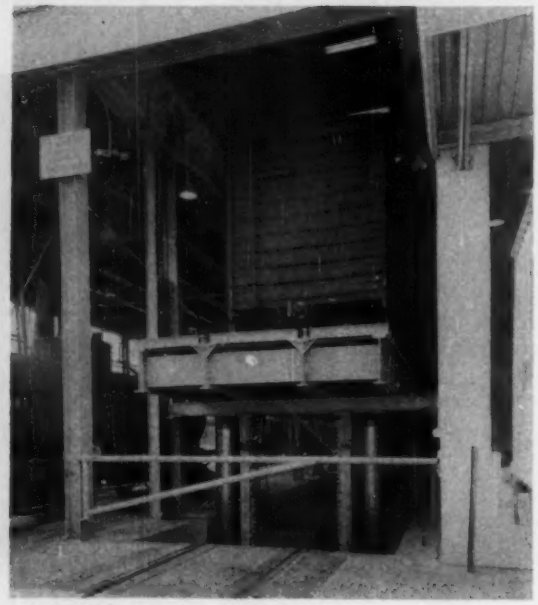
In one sense, storage in a package warehouse is that pause in the movement of packages where input considerations compete with output considerations. Benefits of increased efficiency in moving goods into the warehouse would be lost if not matched by an equally efficient scheme for moving goods out of the warehouse. Thus, major improvements in storage have been developed to facilitate the input and output phases of package movement.

The various types of gravity racks are excellent examples of improved storage equipment that have been developed. The several forms are: 1. Simple slide consisting of inclined pans or angle shaped sides that permit packages to slide or roll down toward the discharge point as successive packages are removed. 2. Inclined side rails equipped with wheels that support the packages. In this type of rack the packages are supported only along their edges. 3. Inclined wheel conveyor racks. Here the racks con-



Variety of handling equipment is available, enabling a system designer to achieve an efficient solution for a particular warehousing problem. As illustrated here, individual bags can be assembled by an automatic loader and placed on a pallet for conveyor transfer within the warehouse. In the other example, appliances in cartons are assembled by the loader into cubes and transported by trucks equipped with special grab attachments. Highlighting the extent to which various technologies have invaded the warehousing field, the trucks are equipped with two-way radio systems.





Vertical handling equipment has been developed to the point where multistory warehouses present no problem to automatic operations. Contrasted in these illustrations are a system for handling cartons and one for handling freight cars. In carton handling, the packages are automatically spaced out and directed onto vertical conveyor. Individual packages can be ejected from the vertical conveyor at the desired floor in accordance with preset control signals. In the freight car system, instead of conveying packages to and from a lower floor loading platform, the carrier is elevated to a convenient upper level for loading and unloading.

sist of a multiplicity of wheels and the packages are supported at various points. 4. Inclined roller conveyor racks in which the packages are supported by rollers making numerous line contacts across the base of the package.

In automatic systems, packages are placed in the racks by a conveying unit. In other systems, packages arriving in the storage area are manually transferred to the storage racks or, in some cases, to a bulk storage area for later transfer to the storage racks as requirements demand.

Where control of speed of travel is essential, as in the handling of fragile or heavy loads, a powered rack is usually specified in place of the gravity type of rack. A powered rack can be constructed from any type of power conveyor. With this more expensive rack design, the loading end can be at the same elevation or even lower than the discharge end.

Withdrawing From Storage

Among the general factors influencing the complexity of withdrawing items from storage is the all important question of variety—variety of items; variety of order quantities; and variety of shipping destinations, to name but a few. Both manual and automatic means are used in order picking (withdrawing of packages and assembling into order lots).

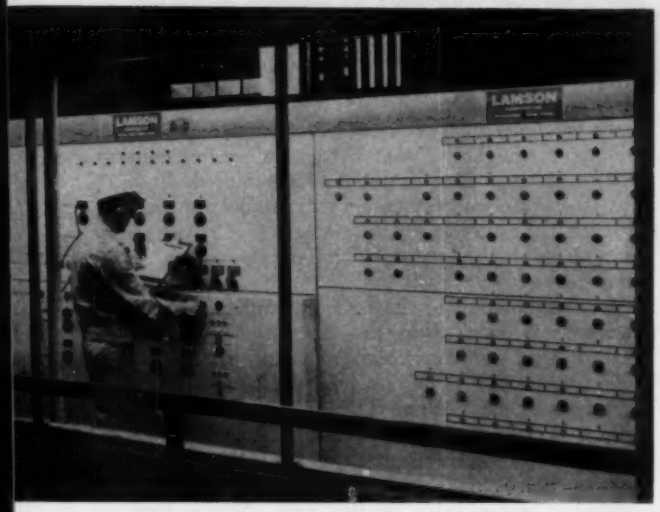
When orders are manually picked, operators move a container through the storage rack area, picking the items required. When the order has been filled the container is then moved to a packing area or to a shipping dock. If baskets or boxes are used as containers, the manual system can be improved by placing the containers on conveyors and transporting the containers through the storage rack area. In such an arrangement, operators are responsible for a certain portion of the storage area, and as containers advance along the conveyor system, the operators read the order accompanying the container and remove items from the racks and place them in the containers. Both gravity and power conveyors are suitable for this arrangement.

Some improvement can be made if the containers are equipped with a simple fixture that supports a card, coded by number or color, to enable an operator to readily identify those containers that require packages from his area. These manual systems depend on the alertness of the operators—and backtracking to obtain an item that should have been placed in the container can become expensive and troublesome.

As a further improvement, then, containers can be equipped with tabs or other signal devices that automatically divert containers onto side tracks at desired points. In such systems, after the operator places packages into the container, the tabs are reset to identify the next deflection point, and the container is redirected back onto the main conveyor line.

The tabs in these applications may be mechanical arms that actuate limit switches or photoelectric circuits, with particular destinations being identi-

Major improvements have followed the introduction of programming equipment into warehouses. The programming systems can be designed to fit all sizes of requirements. Using a desk size console, an operator is shown dispatching packages to desired locations for storage. Included in the conveyor system over which the packages will move are both horizontal and vertical conveyors. In the other illustration, an operator is shown at a large panel board, setting up a particular arrangement of various conveyors in an extensive system.



fied by varying the position or color of the tabs for certain types of scanning systems.

Completely automatic order picking systems have been developed. When packages are to be removed automatically from storage, the discharge end of storage racks is equipped with escapements. These escapements control the discharge of packages onto collecting conveyors that in turn direct the packages to the packing area.

Escapements are found in many forms. Most are arranged so that a mechanical lever, cam, clamp, or shoe is actuated by a solenoid or hydraulic or pneumatic cylinder each time a control signal is received. In other forms, an escapement is provided by a start-stop belt conveyor, whose running time is controlled by a timer (quantity of goods being a function of speed and time). For discrete items, operation of an escapement conveyor can be controlled by a counter control.

Signals that operate the escapements are supplied by manual or automatic means. For automatic operation, signals are created by a program stored on magnetic tape, punched tape, or punched cards. Usually, the tapes or cards also identify the ultimate destination of the package in a packing or shipping area.

With programmed removal from the storage racks, two operating schemes are possible for directing the package to the succeeding area. In one scheme, orders are fed in sequence into the automatic control system and racks are scanned in rotation. The proper number of packages from each storage point is released in turn and the entire order against the warehouse reaches the destination in a slug. Sufficient space is provided between slugs to permit automatic separation of the orders or ready identification of separate orders.

In the second scheme, a multiplicity of orders is collated and the total number of a given package for all the orders is released automatically from the storage line at one time. Conveyed to the shipping or packing area in a group, individual packages are automatically diverted into bins, containers, or areas assigned to the separate orders.

Moving from storage, or the intervening packing operation, eventually packages must be collected at the shipping platform in some manner that takes account of the carrier to be used in shipping. Final preparations at the platform include checking the order and noting shipping weights, etc.

Ideally, as a carrier is ready for loading, the order is ready to be loaded. And, ideally, loading the order onto the carrier will take a minimum of time and effort. Modern equipment is designed to help warehousemen achieve these ideal operations. For example: Orders can be directed over scales which automatically print out the shipping weight; orders can be diverted automatically to specified accumulation points on the shipping platform; and accumulation points can be connected to carriers by portable conveyors that convey the order into the carriers.

The variety of equipment shown in the illustrations accompanying this article supports the original contention that proved equipment designs are available today to bring efficiency to all types of warehouses. The approach to improvement is the same for all—eliminate the unnecessary and improve the necessary, using equipment and components in an imaginative manner to obtain an integrated system.

ELECTROMAGNETIC INSTRUMENT METERS STARCH SLURRY

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FACED with the necessity of replacing several measuring tanks used in the manufacture of corn syrup, Corn Products Dept., Anheuser-Busch Inc., was prompted to investigate the possibilty of improving the operation. The measuring tanks served as an intermediate step in a batch process by predetermining the amount of starch slurry slated for conversion into syrup. In the operation, slurry was drawn from a large storage tank into the measuring tanks, where the volume was visually observed, and then transferred to batch converters. In the converters, the slurry was converted to syrup by heating under pressure in the presence of an acid.

Considering the problem at hand—that of replacing the measuring tanks—it was apparent that what was wanted was a metering system that would feed an exact amount of starch slurry directly from the storage tanks to the converters. Cost of new metering tanks would be avoided and batch loading of the two conversion systems could be controlled automatically. To implement this plan, the company installed a trial metering system designed around magnetic flow meters manufactured by Foxboro Co.

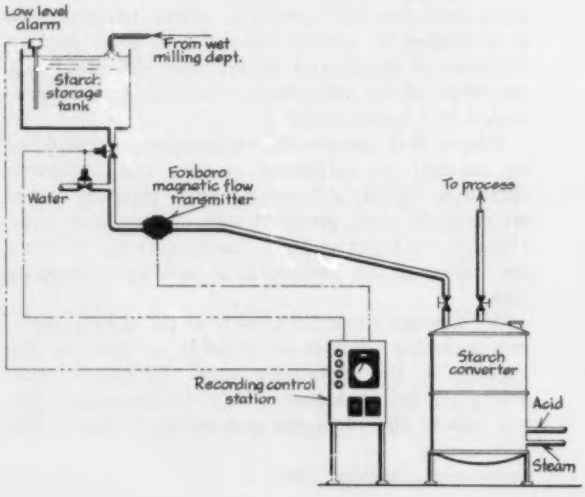
The electromagnetic instrumentation consists of a transmitter and an electronic receiver. Liquid to be metered flows through a straight nonmagnetic tube in the transmitter. The tube has an electrically insulated liner, with two electrodes mounted flush with the inner wall. Two electromagnets are mounted on the outside of the tube. Operation is based on Faraday's law of electromagnetic induction. The flow of the conductive liquid through the magnetic field generates a voltage which is sensed by the electrodes (they are mounted at right angles to both the magnetic field and the flow) and conducted to the receiver.

The meter was tested thoroughly to determine its suitability. Over 100,000 gallons of starch slurry, containing approximately 43.5 per cent solids, were passed through the meter and into a tank calibrated at 40 gallons per inch. The integrator on the magnetic flow meter receiver read only 20 gallons higher than the volumetric measurement of the test tank. Such an error would represent an accuracy of 0.02 per cent. However, since the accuracy of the tank itself was less than this value, a closer assessment of magnetic flow meter performance could not be ascertained.

Other observations were noted during the test: The meter was unaffected by changes in density, temperature, pressure, viscosity, or chemical composition of the liquid measured. During the test, specific gravity of the starch slurry varied from 1.189 to 1.199 with no effect on measurements. The meter was also unaffected by vibration. Since turbulence of the liquor also had no effect, straight runs of meter piping would not be required. And, since there are no restrictions within the transmitter tube, pressure loss was negligible. Converters could therefore be loaded by gravity flow, with no pump required.

Upon completion of the tests, two magnetic flow meters were installed in the lines from the storage tank to the converters, replacing the slurry measuring tanks. The receiving instruments for each system are Foxboro Dynalog recording controllers. When a preset amount of starch slurry has passed through a transmitter tube, a controller closes a valve in the slurry line, simultaneously opening a water valve at the tank. Water flow flushes the line from tank to converter, avoiding possibility of a choked starch line. Since water is normally added to the batch, the flushing water is allowed to enter the converter rather than being diverted to drain. When flushing is complete, the water valve automatically closes.

The cost of the new metering system and its installation proved to be 20 per cent lower than replacement of the measuring tanks with new stainless steel vessels. More important, the accuracy and repeatability of the starch slurry volume delivered to the converters proved more consistent than in the past, thereby assuring corn syrup of identically high quality, conversion after conversion.



Magnetic flow transmitter meters desired amount of starch slurry to converter in semiautomatic process. Flow from storage tank is cut off automatically when transmitter signals recording control station that preset amount has passed. Subsequently, the line is automatically flushed with water and the batch conversion of slurry into syrup is begun. The meter can be used for almost all process liquors in corn wet milling industry. Within certain limitations, conductivity of liquors can be as low as 20 micromhos/cc.

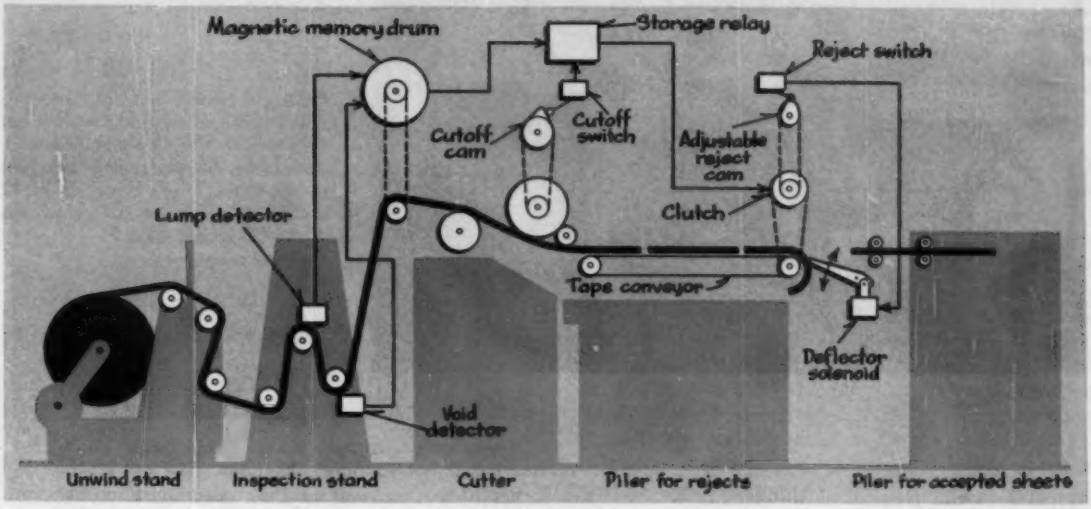


Fig. 1—Paper finishing machine receives rolls of paper, detects flaws, cuts web into sheets, and separately piles good and bad sheets. Selective handling of sheets is controlled by an electrical system including a magnetic information storage drum and cam and switch arrangements.

SYNCHRONIZED DELAY SYSTEM

CONTROLS SHEET SORTING

PAPER is usually produced in long continuous webs. But many users require paper that has been cut into sheets, inspected for defects, sorted, and piled into stacks. The automatic paper finishing machine illustrated by *Fig.* 1 will accept a roll of paper from 32 to 82 inches wide, up to 42 inches in diameter; cut it into sheets; and separately pile good and bad sheets. The Dexter Co. Division of Miehle-Goss-Dexter Inc. developed this machine in co-operation with S. D. Warren Co. and Champion International Paper Co.

This new paper finishing machine thus performs in one continuous operation all the steps necessary to produce a neat stack of good sheets from a roll of paper. Even at paper speeds of 400 feet per minute, the control system selectively separates good and bad sheets. Principally because of web-tension control at the unwind stand, length of sheets is held within 1/64 inch of nominal size. An electronic side guide is used on the unwind stand to keep the web traveling true. The machine is also equipped to trim the edges of the web when desired. Trimmings are pneumatically conveyed to a waste cart.

An important element of the finishing machine is the control system which detects lumps or voids in the paper web and, after the web is cut into sheets, diverts reject sheets to a reject piler. The web is fed from an unwind stand, through tension control rolls, to an inspection stand, *Fig.* 2. This stand includes two inspecting stations. The first of these, *Fig.* 3*a*, detects lumps, wrinkles, welts, and similar flaws. The other inspection station, *Fig.* 3*b*, senses holes, tear-outs, and other voids.

Signals indicating the flaws are recorded on a magnetic drum, *Fig.* 4. Positions of the recording and reading heads around the drum are in proportion to the distances from the inspection points to the cutoff point. The speed of rotation of the drum is determined by the speed of the cutter draw rolls past which the paper web moves to the cutter. A flaw signal is thus synchronized with the arrival of the flaw at the cutoff point.

A relay and a cam actuated switch are used to convert the random flaw signals into a single reject signal associated with the sheet that contains those flaws. The relay serves as a storage device to indicate whether any flaw signals have been received from the magnetic drum in a given interval. That interval is set by the cam actuated switch to cor-

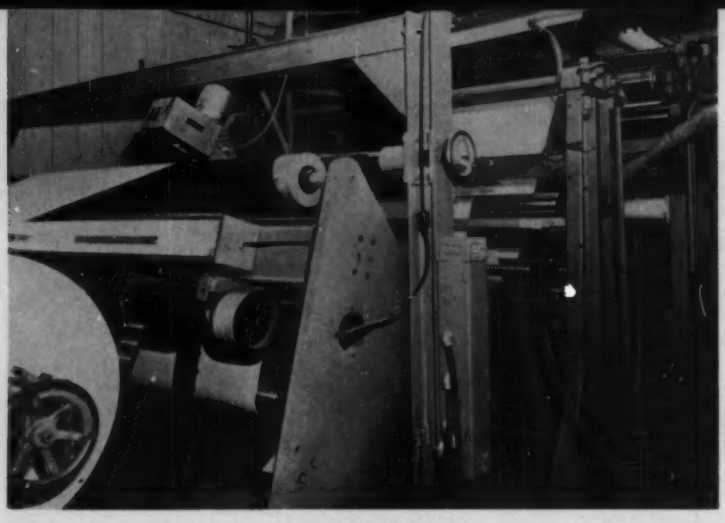


Fig. 2—Partial view of finishing machine shows unwind stand at left with tension stand, inspection stand, and cutter in succeeding positions to the right. Rolls from 32 to 82 inches wide may be cut into sheets 36 to 80 inches long.

respond to the passage of the length of one sheet past the cutoff point. The cutoff cam is driven at the same speed as the cutter flyknife, and at the moment that a sheet is severed from the web, the lobe on the cam actuates the cutoff switch.

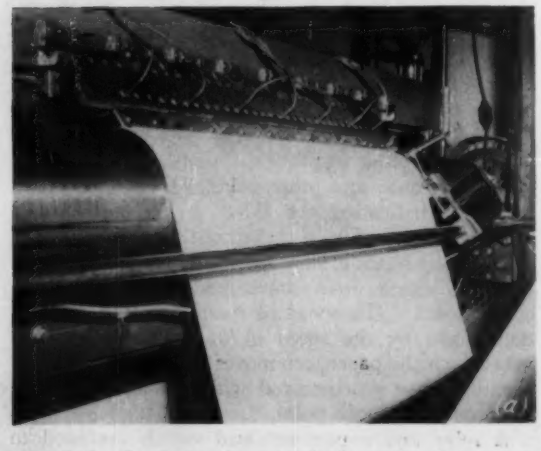
When the cutoff switch is actuated, if the relay indicates a sheet just cut off contains flaws, a signal is sent to a reject deflector, *Fig.* 5. The relay is then cleared to store a possible reject indication for the succeeding sheet. When the deflector solenoid is energized, fingers are raised that divert the reject sheet to a reject piler. If the fingers are not raised, the sheet advances over them to a piler for accepted sheets, *Fig.* 6.

The relay network is so designed that it will generate a false signal to reactuate the deflector for the next sheet if a flaw signal is received from the magnetic memory drum as the cutoff switch is actuated. Such a condition represents a flaw falling very close to a cut. In such a case both the sheet ahead and the sheet behind that cut are rejected.

When a reject sheet is to be passed under the deflector fingers, they must be raised in time to accept the leading end of the sheet, remain up long enough to allow safe passage of the tail end, and be re-positioned as required for the succeeding sheet. The progress of a sheet from the cutoff knife to the deflector and under or over the deflector fingers is determined by the speed of the conveying tapes that carry the sheets away from the cutoff point.

Application of the reject signal to the deflector solenoid must be synchronized with sheet advance. The control system uses another cam and switch arrangement to accomplish this. When a reject sheet is cut off, the cutoff switch and storage relay energize a clutch driving a reject cam. A lobe on the reject cam operates a switch at the required time and for the necessary interval to deflect the reject sheet. Since it is possible to have up to three sheets in the conveyor tapes to the deflector, three reject cams and switches are used.

The cams can be individually driven from the tape conveyor drive by one-revolution clutches. When a reject signal is received from the cutoff



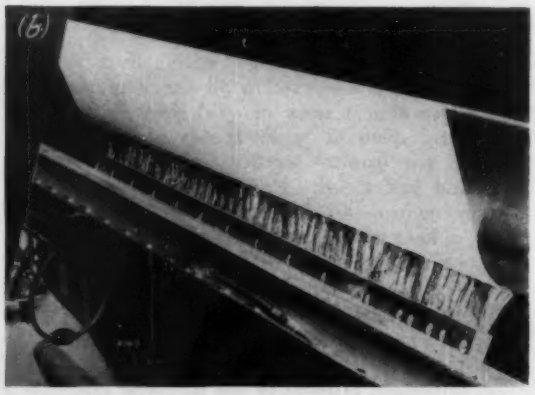


Fig. 3—In the inspection stand, the web of paper is continuously inspected across its whole width. Skids *(a)* ride on the surface of the paper as it passes around a roll. Any lumps are detected and an electrical flaw signal is generated. Conductive brush *(b)* senses any voids in the web and also initiates flaw signals.

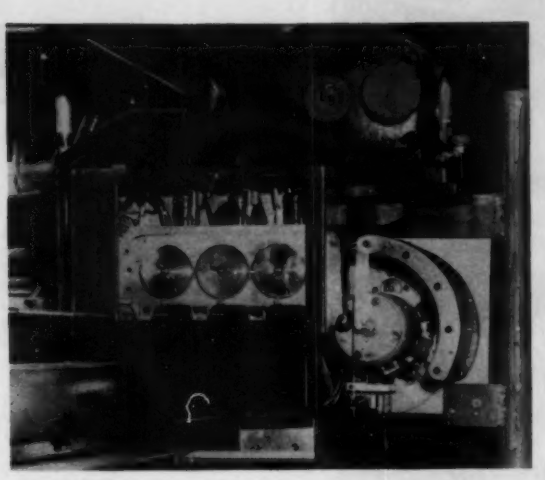


Fig. 4—As flaw signals are generated, they are recorded on the small magnetic drum behind the semicircular shield at right. Signals on the drum are applied to a relay when the respective flaws pass the cutoff point in the machine. Reject signal for a sheet containing a flaw energizes a clutch to drive one of the three cams visible in opened enclosure at left. Each cam operates a switch to actuate deflector fingers at the proper time and for the interval required to divert the faulty sheet to a reject pile.

switch and relay, the clutch is energized for the first reject cam. If another reject signal is received while the first clutch is energized, the clutch for the second reject cam is energized; and similarly the third reject cam may be energized.

The length of the lobe on each cam is adjustable to hold its respective switch actuated for the interval required for a sheet of given size to pass over or under the deflector. The drive ratios to the cams are such that one revolution of a cam is accomplished for a conveyor tape advance equivalent to the distance from the cutoff point to just beyond the deflection point.

Good sheets pass over the deflector fingers and are discharged into a piler (sometimes called a layboy). A counter indicates the number of good sheets as they are piled, and marker tapes are automatically inserted every 25, 50, 100, 250, or 500 sheets as desired. Sheets are fed into the piler 15 to 20 inches apart to permit one sheet to partially settle on the pile and be jogged into alignment before the next sheet arrives.

Forwarding wheels, which advance the sheet from the conveyor tapes to the pile, automatically slow down as the last few inches of the sheet pass. This slows sheet advance to prevent damage to the leading edge of the sheet as it hits the piler stops. To expedite settling, a timed air blast blows down on the top of the sheet as it is positioned over the pile. Joggers along the sides of the sheet are oscillated sharply, and they have holes, countersunk on the ends toward the pile, so that they create a fanning effect which speeds the exit of air from beneath the settling sheet.

Reject sheets are directed under the deflector fingers to a second piler. Since neatness of the reject pile is not as important as that of the accepted pile, a simpler slowdown and jogging arrangement is used for rejects.

Fig. 5—Conveyor tapes at left bring sheets from cutter to deflector fingers. Raised by solenoid, fingers are shown as they deflect a sheet to reject piler. Fingers are lowered to allow good sheets to advance to piler for accepted sheets.

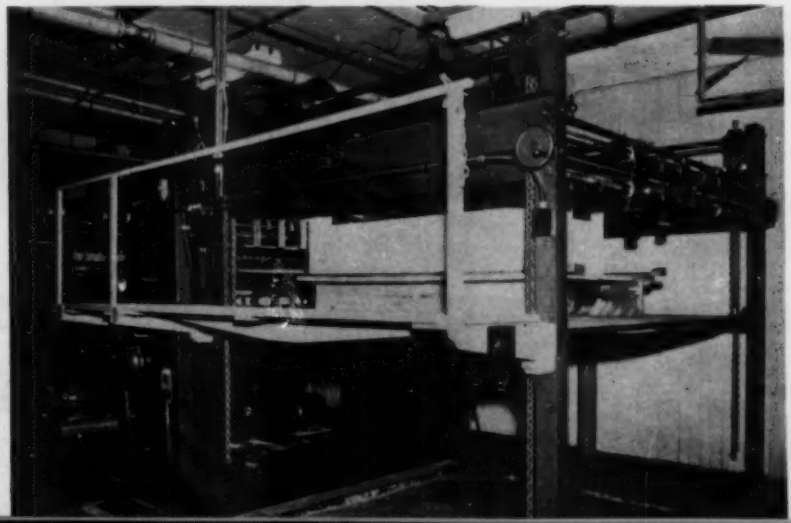
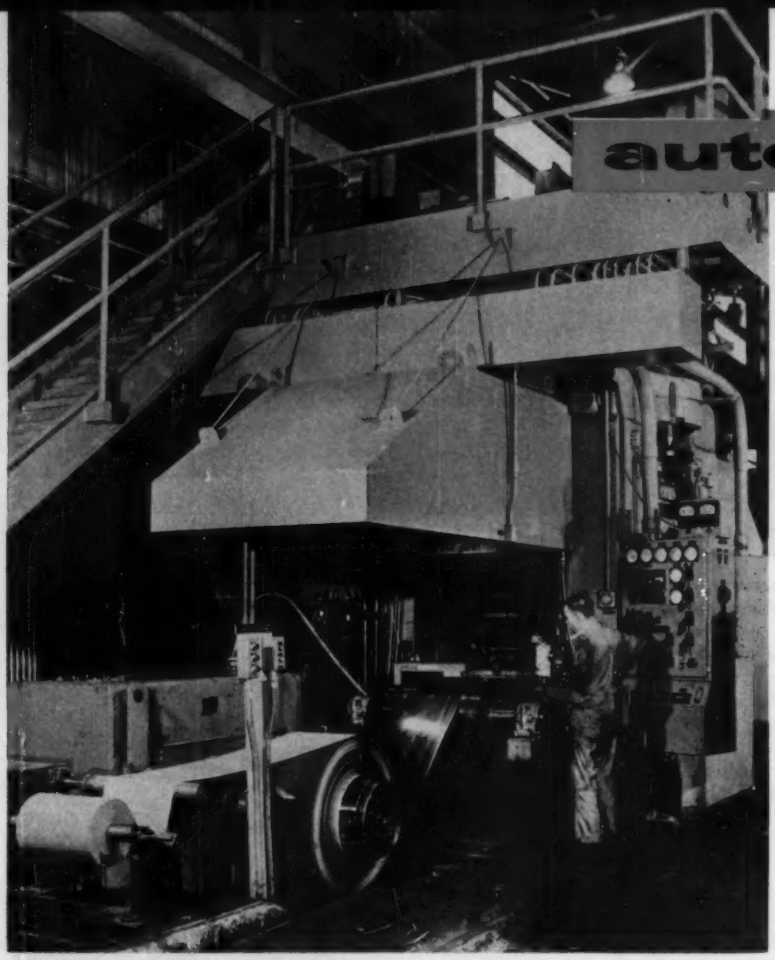


Fig. 6—Good sheets are shown stacked on pallet in piler for accepted sheets at right. Piler for rejected sheets is at left, but stack is not visible.

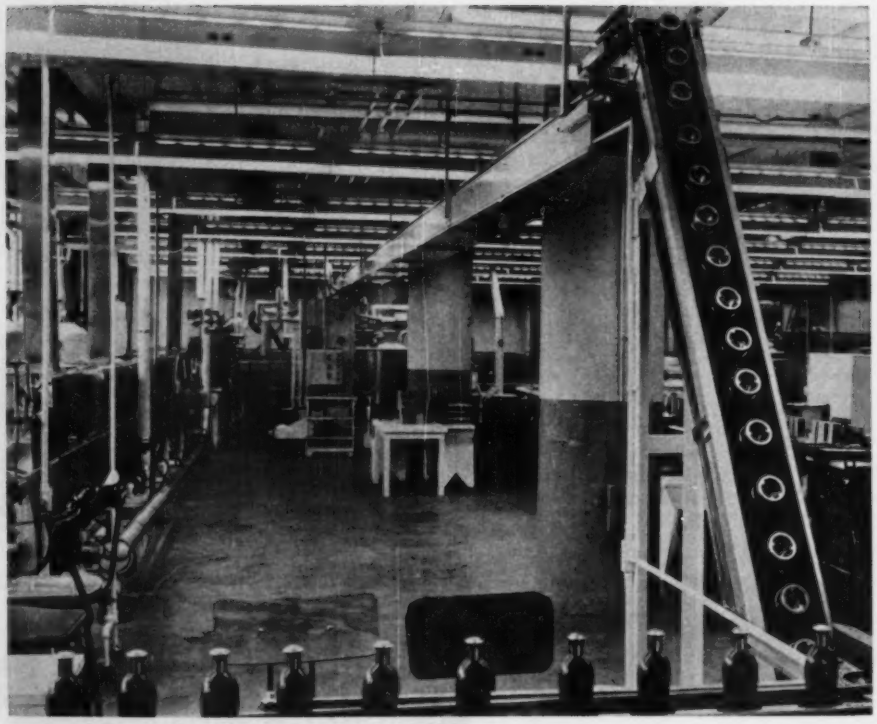


Reversing Cold Mill

FOUR-HIGH reversing cold mill, built by Rolling Mill Div., E. W. Bliss Co., turns out various grades of stainless steel at Universal Cyclops' Coshocton, Ohio, plant. The mill handles all hot-rolled coils coming into the plant, rolling the metal in five passes to an intermediate thickness ranging from 0.040 to 0.060 inch. Following this rolling, coils are annealed and pickled prior to the finish rolling operations. Because of the fine finish required, paper unwinders and winders are provided as auxiliary equipment. However, the mill provides enough tension to keep the coil from pulling on itself and scratching the surface of the strip, and the coil is rolled with an interleaved paper strip only on the last pass. The stainless steel strip is used in automotive, appliance, cutlery, and cookware industries.

Magnetic Handling

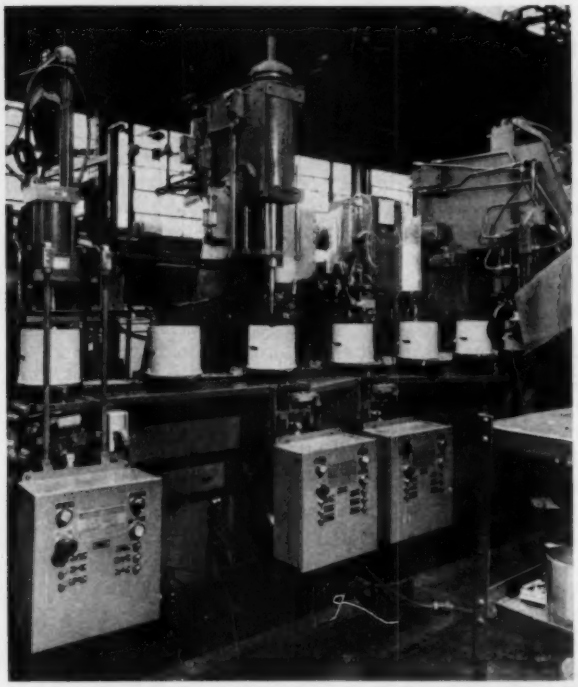
FILLING, testing, and capping of bottles at the Suffern, New York, plant of Avon Products Inc. is accomplished on a continuous production line. To keep the bottles upright and steady during processing, they are placed in individual fixtures, or pucks, made from plastic or aluminum with an iron metal ring inserted in their base. At the end of the production line, the bottles are removed for packaging and the pucks are transferred back to the head end of the line. Shown in the illustration, the pucks are picked up by an Eriaz Mfg. Co. inclined magnetic belt conveyor that attracts the metal ring inserts in the base of the pucks. An overhead conveyor then moves the parts to the beginning of the line. The system replaces a previous method in which hand carts were used to move the empty fixtures between the ends of the production line.



in action

Film Packaging

DEVELOPED by Amsco Packaging Machinery Inc., equipment permits controlled edge sealing of polyethylene bagged packages. The illustrated installation at a MGM Records plant involves an intake conveyor which feeds filled polyethylene packages into an automatically operated heat sealer. A tight-to-product edge seal is provided and excess film is automatically removed and disposed. A photoelectric control system halts operations if a package is misaligned on the conveyor. If desired, equipment can contain a perforator-slitter attachment that perforates the package, permitting the polyethylene film to be easily torn open. Baked goods, paper goods, housewares, and soft goods are examples of items which have been handled by the system.

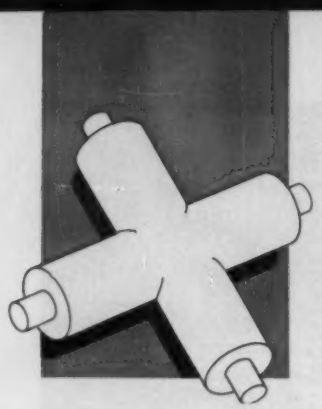


Bearing Sizing

SIX-STATION automatic line at General Electric Co.'s Disposall manufacturing facility includes a "Bearingizing" tool to size powdered metal bearings. In the early assembly stages during manufacture of the garbage disposal appliances, bearings are loaded into housings, pressed into place, and then peened and work hardened by the Bearingizer. At subsequent stations various mounting holes are drilled into the housings, and the motors are assembled to the units. The bearing finishing tool is manufactured by Cogsdill Tool Products Inc. The rotating tool consists of a series of cam-actuated hardening rollers which operate on the bearing surface as the tool is inserted into the bearing. Tolerances of ±0.0006 inch and a surface finish of 7 microinches are obtained with the sizing tool.

Process Control

BYPRODUCTS processing plant of Petroleum Chemicals Inc. and Calcasieu Chemical Corp. employs electronic data processing and temperature monitoring equipment manufactured by Hagan Chemicals and Controls Inc. Shown in front of panel board containing recording instruments, data logger monitors some 500 variables and logs 180 of the variables every half hour. The illustrated equipment is located in a plant that produces ethylene.



MODULES COMBINE TO PERFORM

ELECTRONIC GAGING AND SORTING

Automatic inspection of parts for physical characteristics is attaining a production status in many manufacturing areas. Equipment capable of performing this function can also classify and segregate parts according to their properties. Electronic gaging and control elements having the required accuracy, speed, and versatility for use in such equipment are described in terms of their application in an actual, working unit.

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A CONTINUING TREND in manufacturing is toward the routine production of parts to dimensional tolerances approaching those attainable in the past only with toolroom equipment. Accompanying the trend toward tightened dimensional tolerances is a discernible increase in the number of part designs that require the holding of critical relationships between points or surfaces. These two influences—tightened dimensional tolerances and increased part complexity—are demanding greater accuracy and flexibility of gages used to check parts and subassemblies.

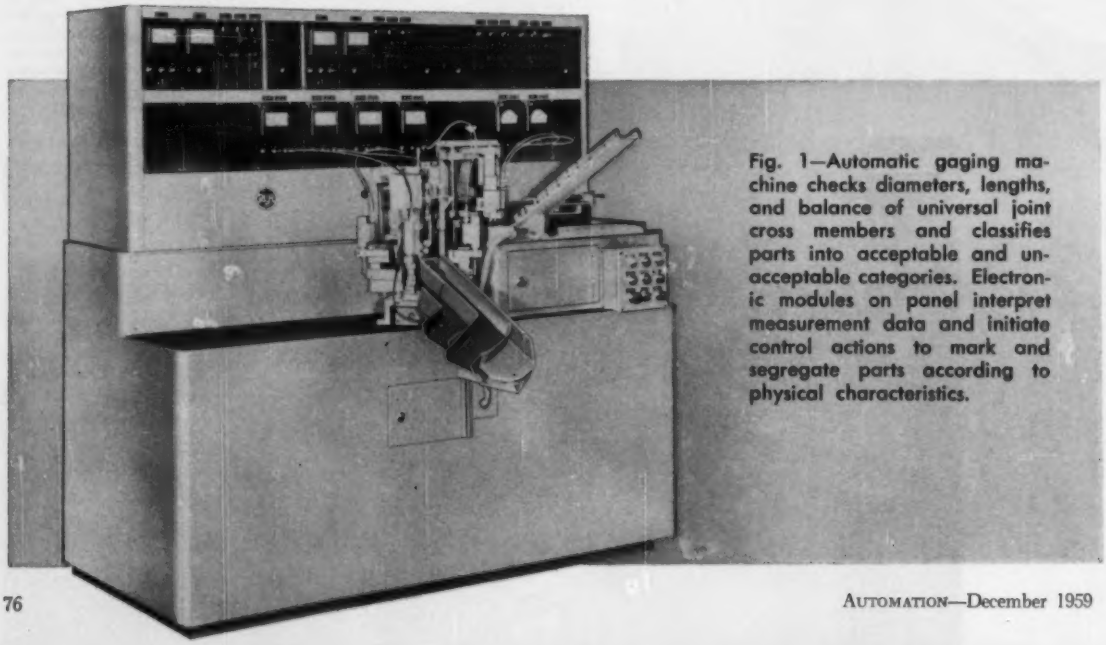
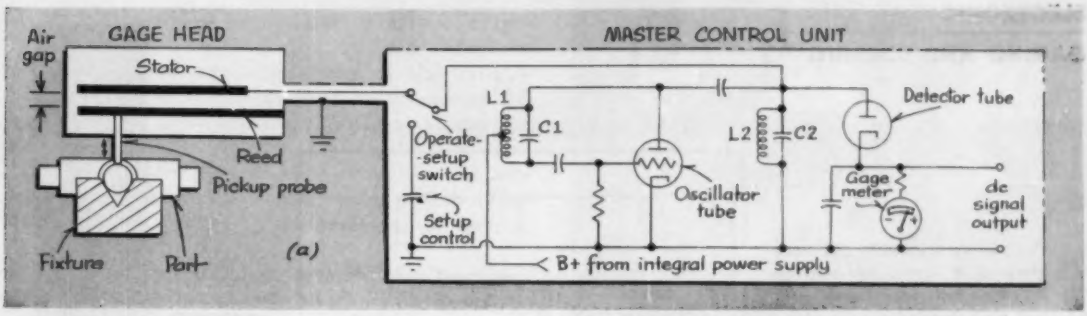


Fig. 1—Automatic gaging machine checks diameters, lengths, and balance of universal joint cross members and classifies parts into acceptable and unacceptable categories. Electronic modules on panel interpret measurement data and initiate control actions to mark and segregate parts according to physical characteristics.



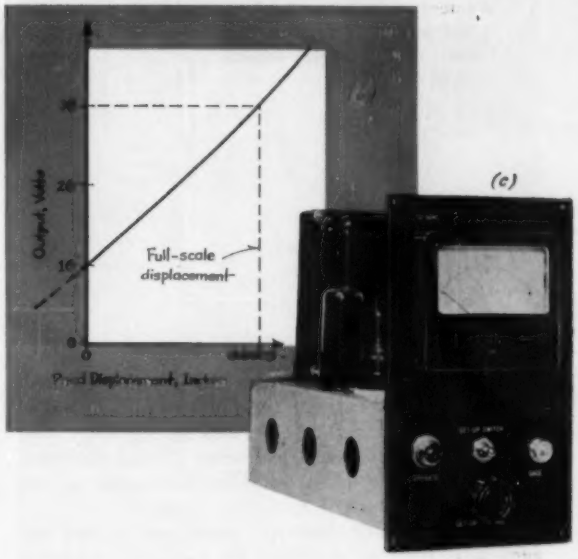


Fig. 2—Gage head and master control unit, *(a)*, are basic items for sensing part dimensions and converting data to proportional dc signals. Characteristic curve example, *(b)*, illustrates virtually linear relationship between physical displacement of gage head probe and output voltage of master control unit. Close-up, *(c)*, shows physical appearance of master control module.

As requirements for gaging accuracy and flexibility become more stringent, manufacturers are increasingly led to consider the advantages of electronic devices for sensing and interpreting parts inspection data. Characteristics of electronic gaging systems—fast speed of response, accuracy, flexibility of use, and compatibility with conventional electrical circuits—suit this class of equipment for a variety of industrial measuring and control applications. Typical jobs might be multiple dimensional gaging and segregating, contour and out-of-roundness inspection, high speed hardness testing and classification, and post-process grinder control. Representative products to which electronic gaging has been adapted include valves and valve springs, pistons and piston pins, ball and roller bearings, and universal joint cross members.

An automatic, electronic gaging machine for determining three important properties of universal joint cross members, *Fig.* 1, exemplifies the versatility of inspection machines that gage parts electronically. Built by Industrial & Automation Div., Radio Corp. of America, the machine accepts cross members placed in a chute, feeds them to fixtures in a dial indexing mechanism where they are subjected to dimensional inspection at two dial stations, and discharges good and bad cross members to separate exit chutes.

Inking or metal stamping devices may be actuated to mark the part sizes sensed by the inspection heads; and multiple discharge chutes may be provided to collect the parts into several good categories, an oversize, and an undersize classification. Meters on the machine panel indicate part sizes for setup and calibration purposes, and signal lights flash to indicate the size classification of each part measured.

The critical dimensions of a universal joint cross member are: 1. The diameters of its four bearing surfaces. 2. The over-all lengths of its arms. 3. The "balance" of the cross member. A part is in balance when each arm bisects the other at the exact center. Diameter measurements can be taken directly, but the determination of over-all arm length and balance are made indirectly by taking such direct measurements as can be made and then combining them algebraically. The latter calculation is made automatically by elementary computing circuits.

▶ Basic Modules

Essentially, RCA electronic gaging systems are made up of combinations of basic modules arranged to suit special requirements. The selection of modules for the cross member gaging machine reflects one such combination. By assigning a relatively simple task to each module, the units are easily understood, maintained, and used. Flexibility is enhanced, since the modules can be arranged in numerous ways. Also, by combining them with other components such as memory units, it is possible to assemble equipment which can arrive at relatively complex indirect measurements and decisions.

A fundamental element of an electronic dimensional gaging system is an input transducer capable of converting physical displacements to proportional electrical signals. This function is performed in the cross member gaging machine by a series of electrostatic gage heads of the type shown on the left in *Fig.* 2*a*. In these devices, motion imparted to a reed through a pickup probe is reflected as a change of

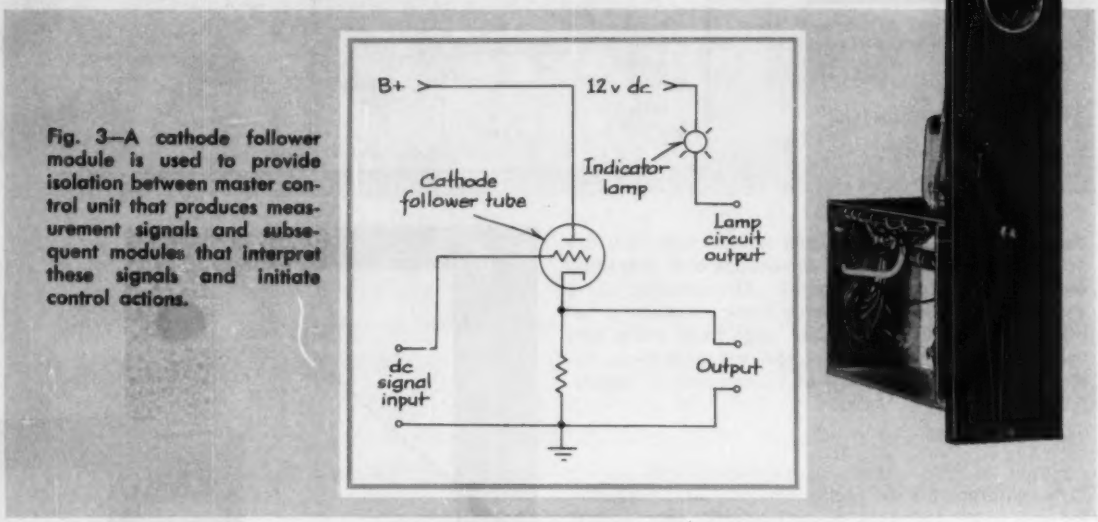


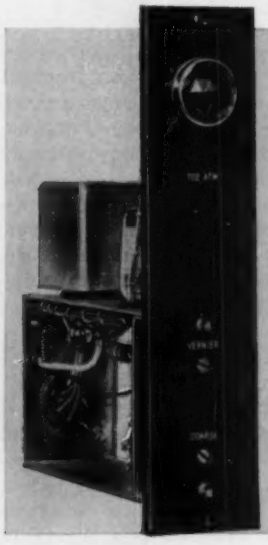
Fig. 3—A cathode follower module is used to provide isolation between master control unit that produces measurement signals and subsequent modules that interpret these signals and initiate control actions.

capacitance between the reed and a stator element. A notch in the reed near the point of attachment of the reed to a shielded case permits flexing of the reed without generating electrical noise. Total excursion of the pickup probe in a typical measuring operation may be as small as 0.0005 inch.

The electrostatic principle employed makes the gage head immune to effects from external magnetic fields and magnetized objects. Relatively high voltage output permits coupling of the gage head directly to a master control unit without the need for amplification.

The master control unit, right, in *Fig. 2a*, includes a power supply, a high frequency oscillator circuit operating at approximately 15 megacycles per second, and an indicating gage meter. Ordinarily, the oscillator is operated in a slightly "de-tuned" state; that is, with the input tuned circuit (*L1*, *C1*) and the output tuned circuit (*L2*, *C2*) set at slightly different frequencies. Thus, the amplitude of the ac output wave generated by the oscillator is not the peak value attainable at resonance, but a smaller value which is a function of the degree of de-tuning.

When an *Operate-Setup* switch on the panel of the master control unit is placed in its *Operate* position, the gage head is connected in the oscillator output circuit through a coaxial cable. The connection is such that the capacitance of the gage head



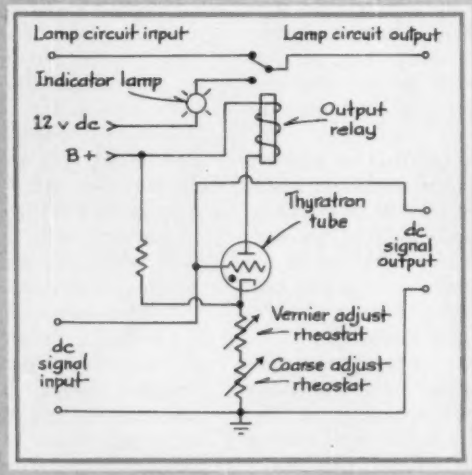


Fig. 4—Control module employs a thyratron tube that conducts and operates relay when signal input voltage, representing a dimension, is at or above a preset level. Firing, or conduction, point is adjusted with coarse and vernier rheostats. Parts may be classified into several size categories when multiple thyratron units, each set to conduct at a different signal level, are used.

is effectively placed in parallel with the output tuned circuit. Tuning of the oscillator then depends upon the combined effects of the variable gage head capacitance, the fixed inductance of *L2*, and the fixed capacitance of *C2*. Thus, changes in gage head capacitance—caused when the gage pick-up probe is brought into contact with a precisely located part—affect the state of tuning of the oscillator and establish the voltages applied to the detector circuit.

The detector converts the variable, high frequency ac voltage from the oscillator to a variable dc voltage which is the output of the master control unit. A meter in the cathode circuit of the detector is calibrated to read the size of the part being measured.

Sensitivity of the master control unit is such that full-scale deflection of the gage head will result in an output voltage change of 20 volts. Response over this range is virtually linear, *Fig. 2b*. Physical appearance of the basic master control module is shown in the close-up, *Fig. 2c*.

▶ Control Units

The combination of an electrostatic gage head and a master control unit is sufficient to enable direct measurement of part dimensions, with meter readout of the values of these dimensions. Mechanically, all that is required is a suitable fixture for the parts, with the gage head properly mounted so as to contact the parts. For indirect measurements, and for automatic control purposes, however, additional electronic modules are required.

One of the additional modules that may be required for advanced measuring and control purposes is a cathode follower, *Fig. 3*. This unit provides isolation between the master control unit and subsequent modules, and is used if the number of additional modules is large. Output of the cathode follower is virtually the same as the output of the master control unit—that is, a dc signal having a voltage proportional to the displacement of the gage head pickup probe—except that it has a more favorable impedance and/or power level for driving the additional electronic equipment. A signal light mounted on the panel of the cathode follower may be connected in a separate circuit. Typically, an amber light is used that is operated when a dimension being measured is at or below a lower limit.

For automatic control actions (lighting of lamps, operation of part segregators, etc.) in response to gage head measurements, modules containing thyratron tubes are used. Each thyratron module, *Fig. 4*, can be adjusted so that it fires and actuates an output relay when a dc input signal is at or above a predetermined voltage level. A multiplicity of thyratron modules may be fed from the output of a single cathode follower. Thus, a part can be classified into a dimensional category by adjusting each thyratron module in a group so that it fires at a different voltage, corresponding to a particular dimension or limit.

When an input signal having a voltage level corresponding to a given gage reading is received, all of the thyratron modules which have been adjusted to respond to that or a lower voltage level will be fired. In the case of a gage signal reflecting an oversize part, all of the modules in the group will be fired. Therefore, some means is required to prevent more than one control action or visual indication. This is accomplished by the manner of wiring the contacts of the output relays associated with each thyratron module, *Fig. 5*. With this method, only one control action can occur, and only one signal lamp can light, at a time. The module providing these actions is the one set to fire either at or immediately below the input signal voltage level.

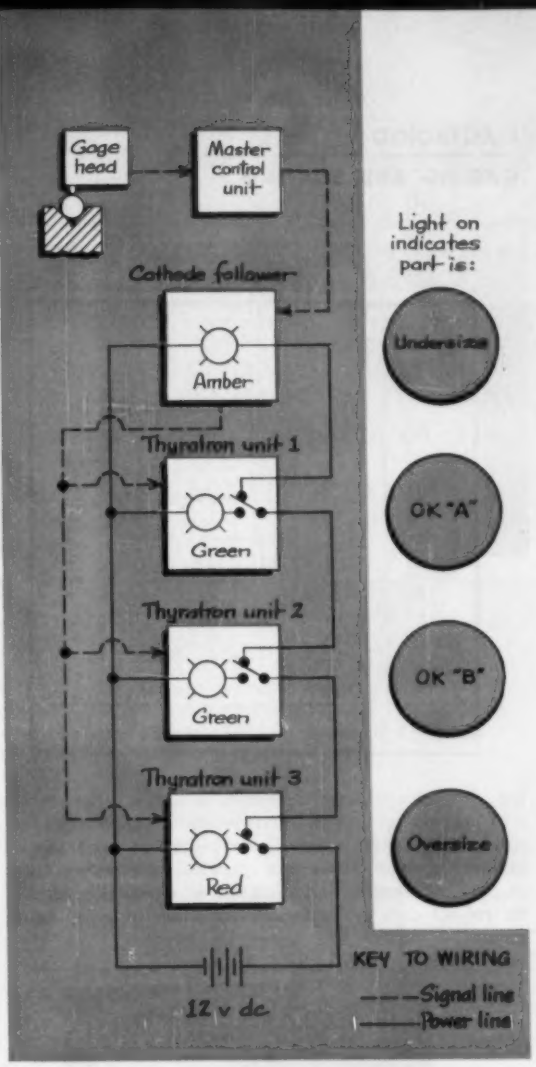


Fig. 5—Method of wiring indicator lamps in setup for classifying parts into several size categories ensures that only the proper lamp will light when a gage signal is received. With no signal, or an insufficiently large signal impressed on cathode follower, *Undersize* lamp is lighted. Assuming a signal level corresponding to OK "B" size category, output relays in thyratron units 1 and 2 will be energized, operating the relay contacts. This will cause the *Undersize* and OK "A" lights to go out and the OK "B" light to go on. The *Oversize* light will remain off because the assumed signal level is insufficient to fire thyratron unit 3.

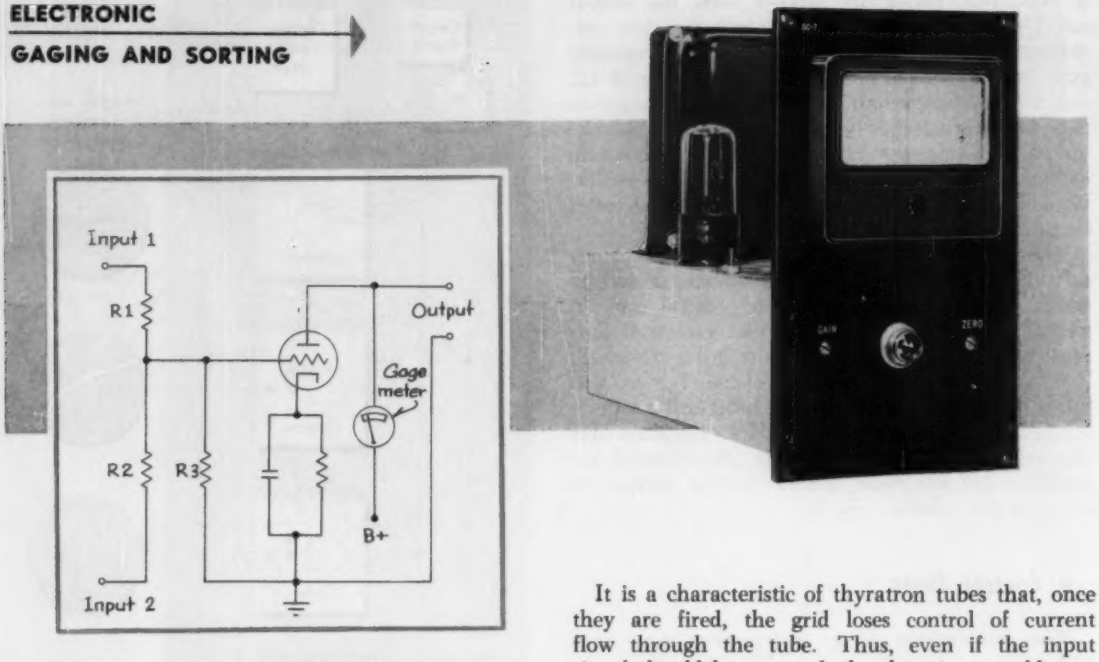


Fig. 6—Sum computer is used to add two input signals and provide an output signal proportional to algebraic sum. Zero-center meter is calibrated so that central pointer position represents nominal dimension (such as over-all length), and readings on either side of center reflect over or undersize condition of parts being measured.

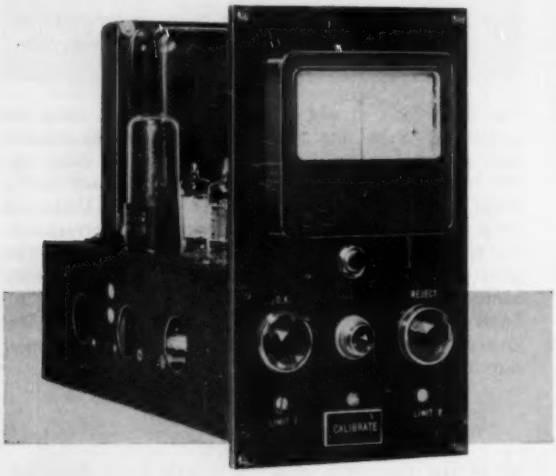
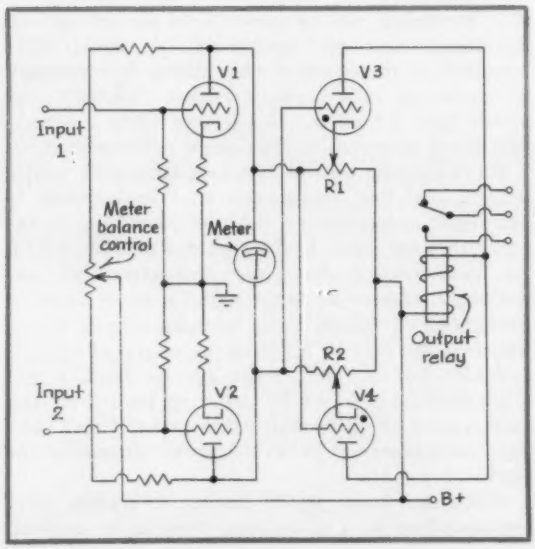


Fig. 7—Difference computer accepts two dc inputs and actuates an output relay when difference in input voltages exceeds predetermined amount. With no signal input, potentiometers *R1* and *R2* are set so that thyratrons *V3* and *V4* are biased beyond cutoff. Application of equal inputs to vacuum tubes *V1* and *V2* results in no change in bias because both grid and cathode potentials of thyratrons are thereby raised together. If input 1 should exceed input 2, however, bias on thyratron *V4* will be reduced and tube will conduct, energizing output relay. Similarly, when input 2 exceeds input 1 by a predetermined amount, thyratron *V3* will conduct and result in a control action.

It is a characteristic of thyratron tubes that, once they are fired, the grid loses control of current flow through the tube. Thus, even if the input signal should be removed, the thyratron would continue to conduct and keep the output relay energized. Therefore, as a part of the automatic cycle of the cross member gaging machine, the cathode circuits of all of the thyratrons are opened momentarily by a cam operated switch during the parts loading and unloading interval when no gaging is being done. This interrupts the current flow with no signal on the grids, and restores grid control so that grid bias can hold the thyratrons in a nonconducting state until another input signal of sufficient magnitude is received. Standard power supplies are available that service thyratron modules in groups of up to nine units.



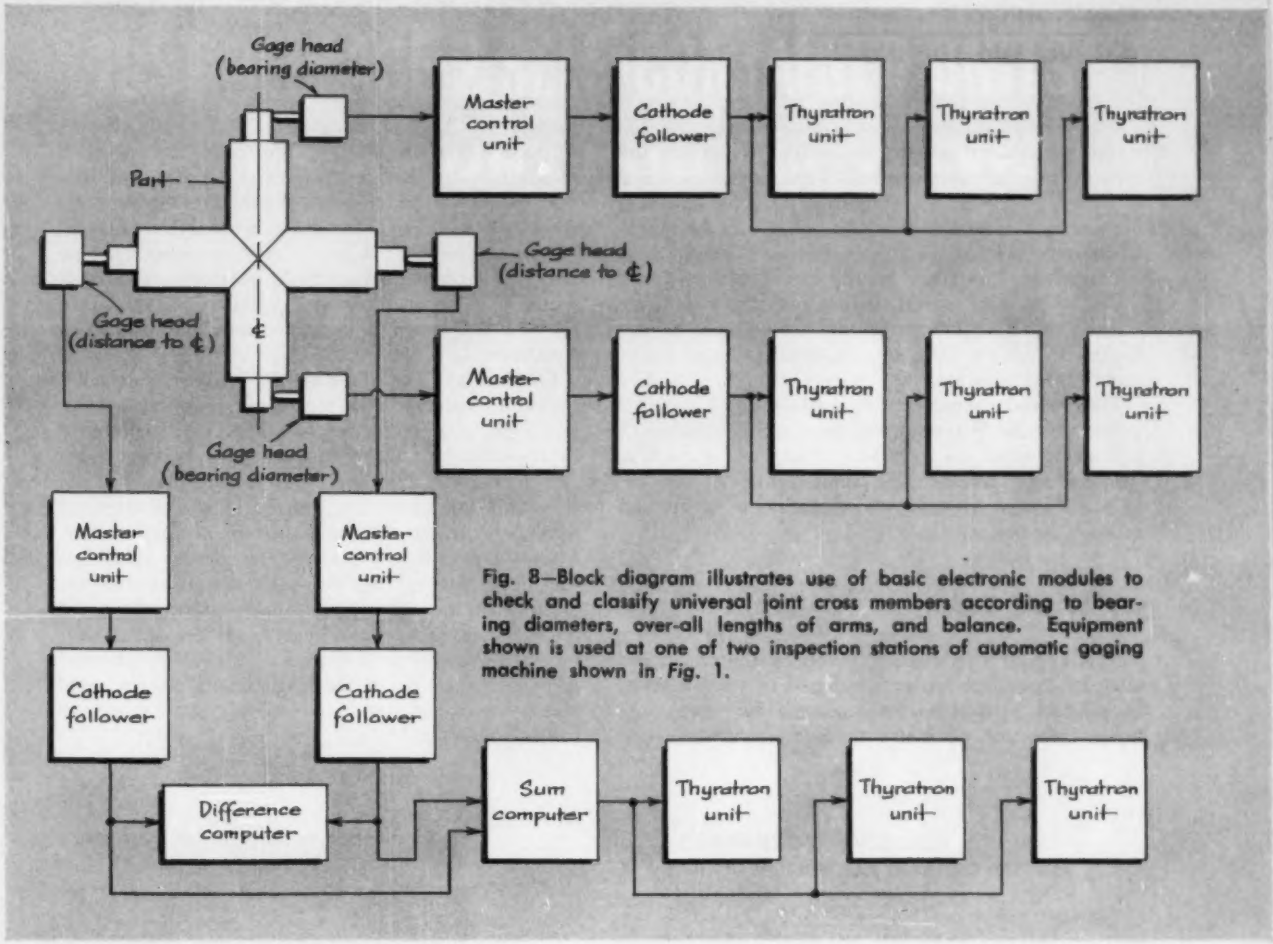


Fig. 8—Block diagram illustrates use of basic electronic modules to check and classify universal joint cross members according to bearing diameters, over-all lengths of arms, and balance. Equipment shown is used at one of two inspection stations of automatic gaging machine shown in *Fig.* 1.

▶ Indirect Measurements

An example of an indirect measurement is the determination of over-all length of a cross member arm. The part is composed of two arms which ideally should bisect each other. With bearing surfaces of one arm in the V-grooved fixture used to support the piece as the bearing diameters are measured, it has been found expedient to measure the length of the other arm in two increments on either side of the centerline connecting the V-supports. Two separate measuring systems—each including a gage head, a master control unit, and a cathode follower—are used to provide the increment signals.

The individual signals are fed to a sum computer, *Fig.* 6, which adds them and forms a composite signal representing over-all length. This device employs a resistance network (*R*1, *R*2, *R*3) in its input circuit which accepts two input signals and converts them to a dc sum analog voltage. A vacuum tube circuit is used to operate a meter that indicates over-all length. When it is desired to classify the parts according to length, an output signal is available from the sum computer that can actuate thyratron modules as in the previous example.

Sum computers are useful wherever it is desirable or necessary to take indirect measurements and add them algebraically to obtain a direct result. This is frequently the case where fixturing, part dimensioning, or other considerations require that reference points be taken at specific locations on parts.

Some types of measurements involve the sensing of differences between two dimensions. This is the case, for example, in determining the balance of a cross member. In checking an arm for balance, measurements are taken to see that each end of the arm extends an equal distance from the fixture V-groove.

The same signals from the two sets of gage heads, master control units, and cathode followers used to determine over-all length of an arm can be used to indicate balance. The only change necessary is in the manner of processing the signals. Both computations—for over-all length and balance—can be made simultaneously.

In balance measurements, the two signals are compared in a difference computer, *Fig.* 7. If the voltage levels of these signals differ by preset amounts

(indicating an excessively unbalanced part), the difference computer actuates an output relay and the part is rejected or classified. Two thyratron tubes are used in the circuit, and firing of either one will actuate the load relay. Each thyratron can be biased a different amount so that upper and lower limits of unbalance need not be the same. A zero-center meter in the unit is calibrated to read the unbalance dimension. The pointer of this meter may be deflected in either direction, depending upon which input signal is larger.

Differential computers are used in other types of measurements. For example, they are applicable in measuring taper on a variety of part types such as spindles and pistons. The same principle—sensing of a difference between two dimensions—is applied in such measurements.

System Design

It is apparent from their functions that the basic modules described can be combined in various ways to produce special-purpose systems for the automatic inspection of many types of parts and subassemblies. A block diagram of the cross member inspection system, *Fig.* 8, illustrates the selection of modules for checking diameters, lengths, and balance of one type of part. When the modules are combined with parts handling, marking, and segregating equipment (as in the cross member application), a complete inspection machine is formed which may be operated as a separate unit or which may be integrated with production and packaging equipment.

Gage heads are available in several models designed to meet special measuring requirements. In one type, multiple input transducers are combined to enable simultaneous measuring of internal taper and bellmouth of holes. Another gage head model is suitable for measuring concentricity, and responds to changes of size definition instead of absolute size. Miniature heads are available for limited-space applications; snout types are quick-mounting and operate with the main body some distance from the part. A line of available gage heads responds to air pressure changes or differentials instead of physical displacements. All of the gage heads can be used directly with the standard electronic measuring and control modules.

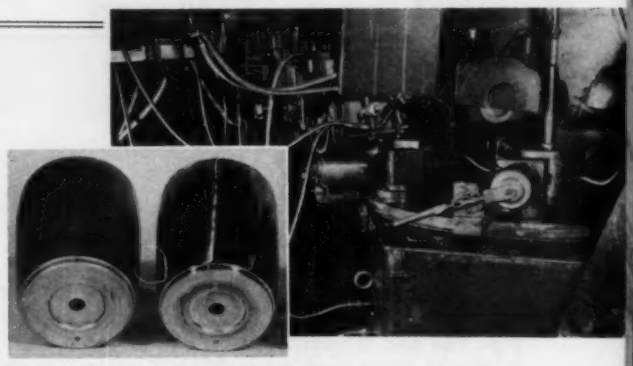
COATED ABRASIVE WORKHEADS FINISH DRAWN ALUMINUM PARTS

FINISHING of drawn aluminum coffee brewer bodies prior to buffing, assembling, and plating operations is accomplished efficiently on semiautomatic equipment at Dormeyer Corp. A basic element of the finishing machine used is a multistation dial indexing table equippel with workholding fixtures. As the table indexes, each fixture is presented successively to six workstations.

The first two workstations employ coated abrasive belt heads that perform roughing and blending operations on parts clamped in the fixtures. Aluminum oxide, resin-bond cloth belts, 8 inches wide by 132 inches long, are used at these stations. The belts, having coarsnesses of 180 and 240 grit respectively, are operated at 8200 sfpm with 15 pounds pressure against the work. Oil is used to lubricate the belts.

To ensure that the parts will be finished over their entire circumferential surfaces, the workholding fixtures are rotated at each workstation. This action occurs during a 21-second dwell period in each indexing cycle. Direction of rotation of the fixtures is opposite that of the workheads at each workstation.

Following roughing and blending, the coffee brewer bodies are subjected to progressively finer finishing treatments at the next four stations. Each of these stations is equipped with an 8 inch wide by 16 inch diameter polishing and grinding wheel operated at 1750 rpm. Developed by Minnesota Mining & Mfg. Co., each wheel is made up of hundreds of die-cut strips of coated abrasive material arranged to project radially from a central hub. As the wheel is rotated, each strip in turn brushes against the work, imparting the desired finish. The strips are readily shaped so that the wheel edge will have the approximate contour of the part to be finished. This ensures even contact between the wheel and the work. The effect of continued operation of the wheels is to wear in their shapes to conform even better with the part contours.



The strips used in each wheel employ silicon carbide coated abrasives having coarsenesses of 240, 280, 320, and 400 grit, respectively, with the finest grit being used in the last workstation. Tripoli oil compound is applied to the wheels. Pressure of the wheels against the work is aproximately 20 pounds, and each polishing and grinding head draws from 5 to 7 amperes during the work cycle.

Average life of the 240 and 280 grit polishing and grinding wheels is 34,000 parts; the 320 and 400 grit wheels last up to 65,000 pieces. These figures contrast sharply with an average belt life of 150 parts when three coated abrasive belts were used in place of the four wheels. An additional advantage of the polishing and grinding wheels is that only one buffing operation is needed prior to assembling and plating the coffee brewers. The photo inset shows typical surface finishes of parts before and after processing on the special purpose, multistation machine.

Circle 675 on Page 19→

After years.... if you do have to "repack"

JUST REPLACE 2 SELF-CONTAINED UNITS

IF IT'S A HUNT PDQ AIR VALVE

You want an air control valve that **one man can completely repack in a minute** on the bench or on the line.

We have that valve for you.

To repack the HUNT PDQ you just slide two simple self-contained units into place. One . . . the poppet spindle-sleeve assembly. Two . . . the plug-in solenoid pilot assembly. That's all!

You want a minimum inventory of spare parts. With the HUNT PDQ valve you stock **only two spare units** . . . not several dozen parts.

One man . . . any man . . . can completely repack the PDQ (including the solenoid pilot section) in less time than it takes you to read this ad. And your line is back in operation again.

This is the valve you want and need. Write today for the full story on the PDQ.

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HUNT VALVE COMPANY · SALEM, OHIO, U. S. A.

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- ☑ Simplicity
- ☐ Speed and Capacity
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The Hunt PDQ valve tops them all in every class.

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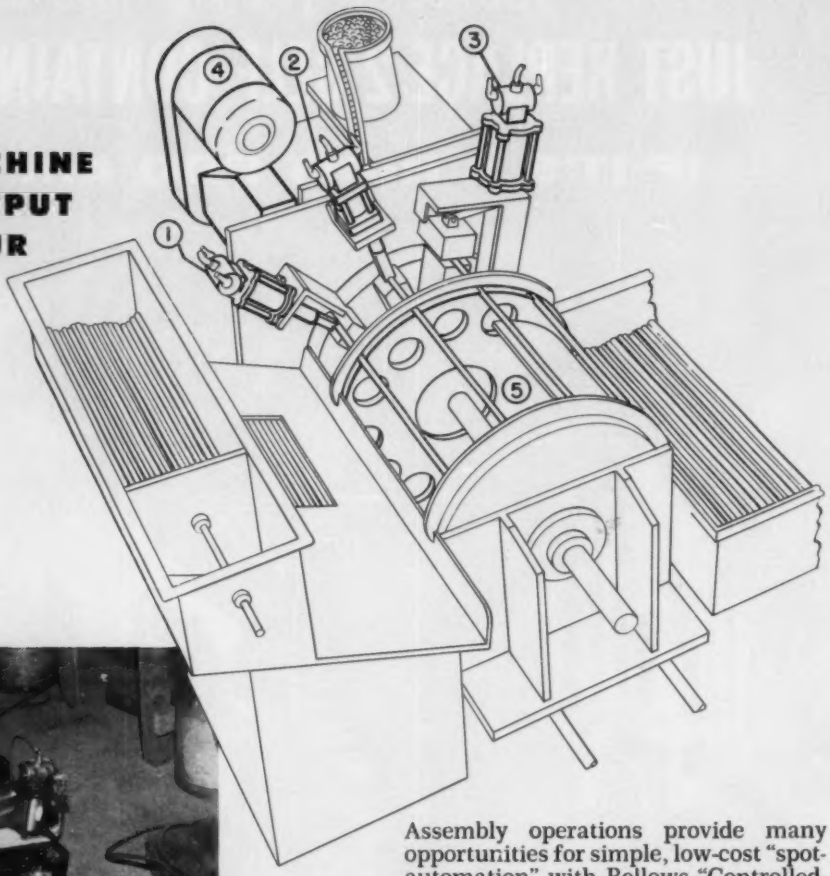
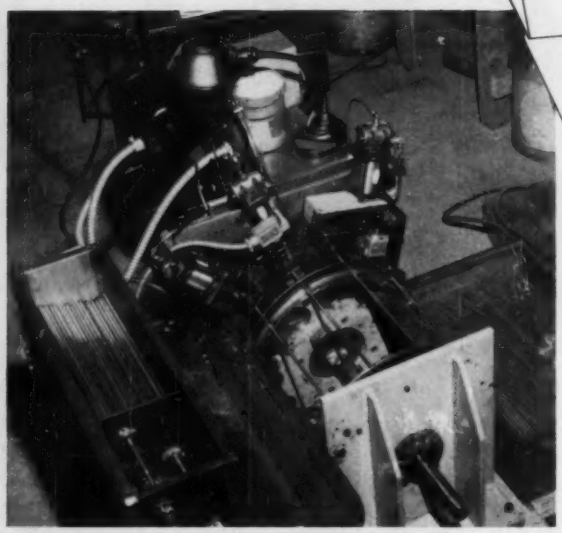
the SPEED and CAPACITY story.

HUNT H V C ***Quick-As-Wink*** AIR & HYDRAULIC CONTROL VALVES

THIS SHOP-BUILT MACHINE INCREASED OUTPUT PER MAN-HOUR 500%





Incorporating five Bellows Air Motors (#1, #2, #3, plus two others, horizontally-mounted, not visible) and a Bellows Drill Unit (#4), all electrically interlocked with the vertically-mounted Bellows Rotary Table (#5) which feeds the workpieces through the various operations, this machine counterbores one end of a .300" brass tube, inserts a small plastic seal, curls the end of the tube to retain the seal and delivers the completed antenna sub-assembly into a hopper ready for plating.

Assembly operations provide many opportunities for simple, low-cost "spot-automation" with Bellows "Controlled-Air-Power" Devices. Costs go down immediately as these versatile work units boost the productivity of each worker.

A case in point is this machine, built entirely around Bellows "Controlled-Air-Power" Devices, which performs an assembly sequence in the manufacture of automobile antennas. Designed by the Plant Superintendent working with a Bellows Field Engineer, the unit requires only one operator (who merely loads and unloads hoppers), yet produces the same number of pieces as five assemblers working manually.

This machine is typical of the ways that cost-conscious men are using Bellows "Controlled-Air-Power" Devices — either singly or in combinations — to perform a virtually-unlimited range of operations. It's almost a certainty that Bellows units can help you meet — *or exceed* — cost reduction goals in *your* plant, too.

THIS SPOT-A-MATION IDEA FILE IS YOURS ON REQUEST

Contains installation data, wiring diagrams and equipment lists for numerous Bellows "Controlled-Air-Power" applications, enabling you to automate existing machines or build your own low-cost special-purpose equipment. Write for yours today. Address Dept. AU 1259, The Bellows Co., Akron 9, Ohio.

640-C

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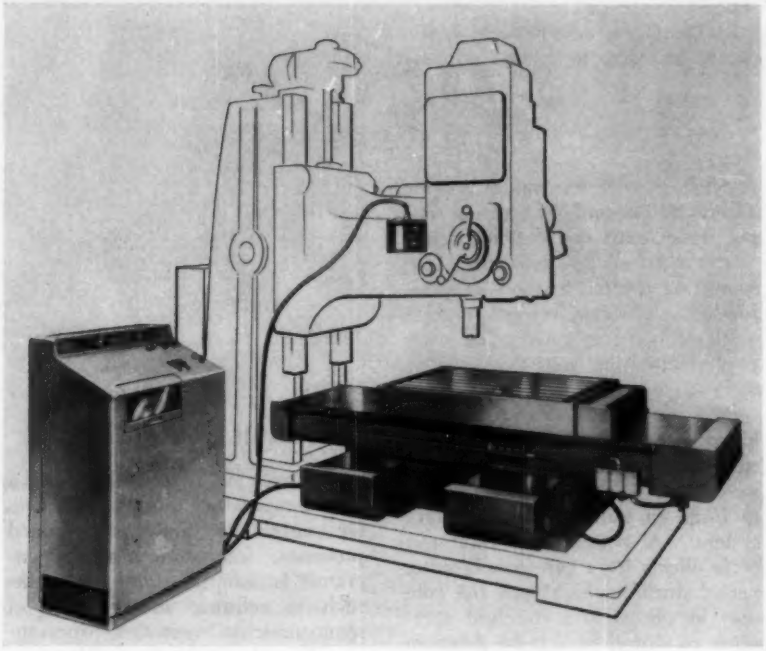
AUTOMATION

new equipment

Machines and plant equipment for more automatic operations.
For detailed information and literature, use card Page 19.



Positioning Table is Numerically Controlled

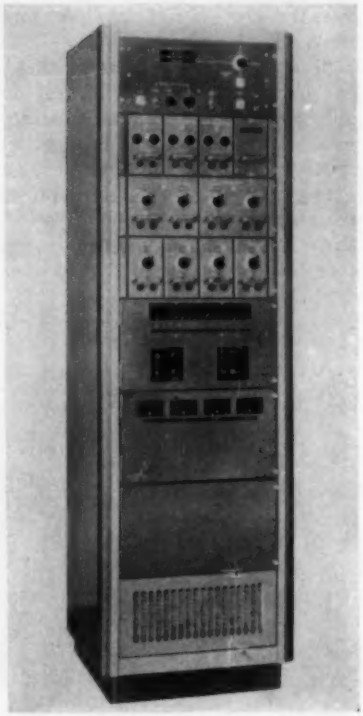
POSITIONING table can be controlled by either punched tape or a manual keyboard, is designed to position up to 5 tons of work for drilling, reaming, boring, tapping, or layout at a rapid traverse speed of 360 ipm and final positioning speed of 20 ipm. Accuracy is within ±0.001-inch and repeatability is within ±0.0005-inch. The table, designed by **Cincinnati Bickford Div., Giddings & Lewis Machine Tool Co.**, Fond Du Lac, Wis., can be used for small work such as printed circuit boards as well as heavy work totaling 10,000 lbs. Travel of the 38 by 50 inch table is 32 by 44 inches.

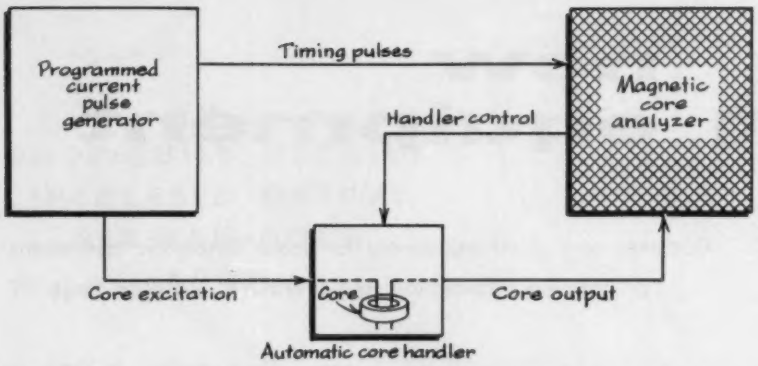
Instructions are punched into 7/8 or 1-inch tape on a standard tape preparation unit. After the tape is prepared, it is placed on a tape transport in a control console and is read by a reader which uses mechanical sensing feelers. A decimal system is used so there are no data conversion tables to work with. If a work print calls for holes or locations other than those punched in the tape, the operator can assume conrtol of the table and insert additional instructions from a keyboard on the console. The input information from the tape is fed to control circuits which in turn operate rapid traverse motors and final positioning servomechanisms. Table operates in all four work quadrants, accepting plus or minus commands in either the X or Y axis or both axes. Programming is done by listing values for the X and Y coordinates for various hole locations or positions.

Circle 401 on Page 19

Analyzer Checks Voltage Response of Memory Core

Suitable for use in production testing of wound metallic tape and ferrite memory cores, high speed magnetic core analyzer automatically measures peak or intermediate values of core voltage response and provides control signals for the





Block diagram illustrates use of magnetic core analyzer in automatic system that tests and classifies computer memory cores according to voltage response characteristics.

classification of parts into various categories. Designated REACT, Model 2040 operates at test rates up to 10 cores per second.

Use of an internal reference core, which is measured a few hundred microseconds prior to the testing of each unknown core, improves the dependability of the equipment. If the reference core fails to test properly, test of the unknown core is automatically considered invalid, and the core is placed in an indeterminant classification for subsequent retest. If invalid tests are indicated in 15 consecutive test cycles, the unit sounds an alarm and shuts off.

Several test modes are possible. In the simplest mode (a "go, no go" test), peak voltage measurements are made of the core response. The core is accepted if its 1 response is greater than a preset minimum and its 0 response is less than a preset maximum. If the core fails one or both criteria it is rejected. Other test modes provide additional information (such as output wave shape and switching time characteristics) by measuring response at specific instants of time. Magnetic counters record running totals of cores in each grade category, facilitating statistical quality surveys.

The core analyzer may be combined with available units such as a core handler and a programmed pulse source (see block diagram) to form an automatic core testing system. A typical automatic test cycle allows for a core conditioning period during which time the core may be placed in a standard operating condition by a pulse program other than the test program; a check interval during which period the internal reference core is measured; and a test period during which time the unknown core is tested. **Rese Engineering Inc.**, 731 Arch St., Philadelphia 6, Pa.

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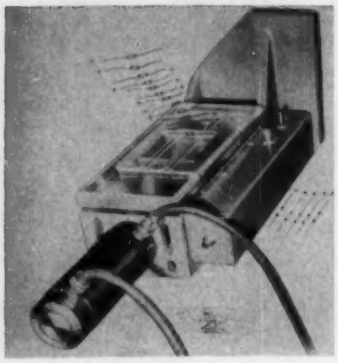

Lead Straightener

Machine can automatically straighten, orient, and feed diodes and other axial lead components into test equipment, taping machines, and marking machines. In operation, parts are hand fed into a drop slot of the lead straightener where they are automatically rolled between two plates. The rolling plate is actuated by an air driven cylinder. The diode activates an electronic sensing unit and, as the next diode is being straightened, the first is rotated 90 degrees in the direction required to orient its anode lead in the proper direction. The diode is then released to fall into the feed mechanism of the next machine, such as a color banding unit. Average operating speeds are approximately 3600 diodes per hour. **Carman Laboratories Inc.**, 10 Carman Rd., Bedford, Mass.

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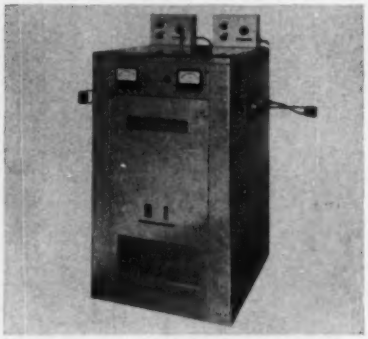

Induction Heating Unit

Available with accessory closed loop temperature controller system for automatic and programmed processes, induction heating generator is adaptable to operations such as refining and growing of semiconductor material, inert-atmosphere brazing of precision nuclear and electronic components, and high temperature analysis of rare earths and metals. Model L4E-C-2 is available in any specified output frequency in the range of 200 kcps to 3 mcps. Generator has a two-station output with individual *Start-Stop* pushbutton stations and power control dials for each station on remote control panels with cables up to 20 ft long. Stepless electronic power output control is continuously variable from 0.5 to 4 kw. Power input for the unit is 230 or 460 v, single phase, 8 kva at full load output. Features include: Magnetic circuit breaker protection in both supply and load circuits, safety door interlock switches, and variable load matching in output circuits for universal heating applications. **Reeve Electronics Inc.**, 609 W. Lake St., Chicago 6, Ill.

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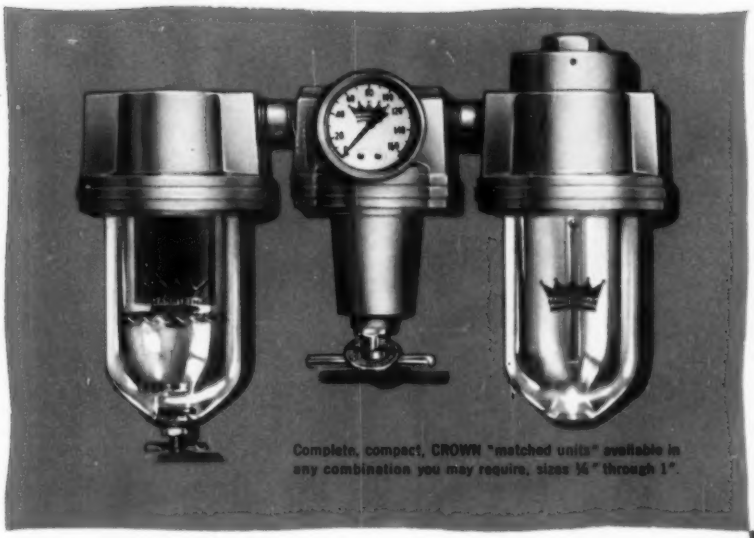
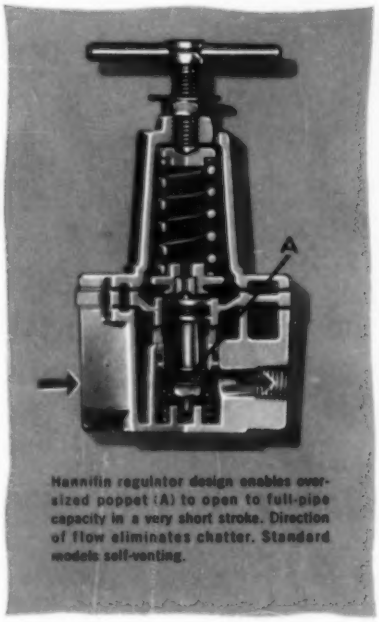
Circle 677 on Page 19→

Crown From HANNIFIN air preparation units that don't waste air power



Complete, compact, CROWN "matched units" available in any combination you may require, sizes ⅛" through 1".



Hannifin regulator design enables oversized poppet (A) to open to full-pipe capacity in a very short stroke. Direction of flow eliminates chatter. Standard models self-venting.

Hannifin CROWN "Combo" units – filters, regulators and lubricators in any combination – keep compressed air in the "pink of condition" without depriving you of needed air flow.

Crown regulators open fast on demand, close precisely when demand is satisfied, deliver the exact amount of air needed. Their "piston balanced" poppet design, which makes possible a flat, large-area, poppet-type valve with very short stroke, is the reason. The inherent stability of this design – no hunting or chatter – results in multi-million cycle life.

Crown filters have large, reusable filter elements for minimum resistance to air flow. Crown lubricators introduce predetermined amounts of oil into the air stream, automatically. Their design is so responsive to variations in air flow rate that the concealed, tamperproof adjustment is rarely used. This is the easiest lubricator of all to fill, and remote-fill models are available.

Crown units are competitively priced and stocked in principal industrial areas by Hannifin CROWN authorized distributors. For CROWN literature and the name of the distributor nearest you, write:

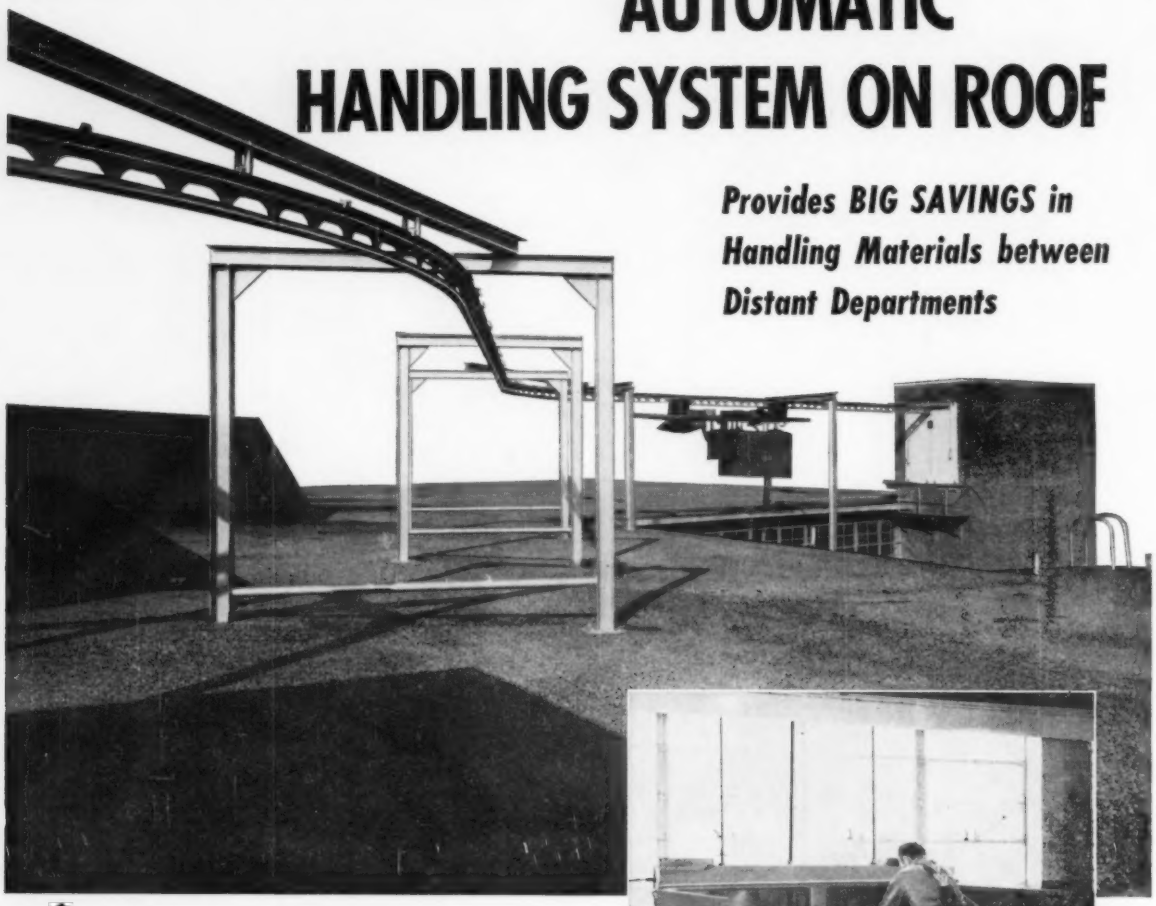
HANNIFIN COMPANY

535 South Wolf Road • Des Plaines, Illinois

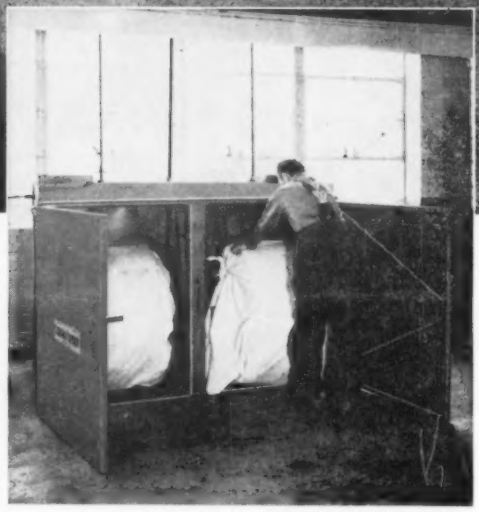
Lubricator valve (A) is factory pre-set for most applications. Valve (B) shuts off air pressure to bowl when fill plug is removed. This patented Hannifin feature permits bowl refill without shutting down air line.

AUTOMATIC HANDLING SYSTEM ON ROOF

Provides BIG SAVINGS in Handling Materials between Distant Departments



The Tramrail carrier seen here is approaching one of the penthouses built at each end of the track. The penthouse doors open and close automatically as the carrier passes through. The load lowers to the floor inside.



Loading Tramrail freight van inside building. At a touch of a button, it hauls heavy loads long distances, day or night, through heat or cold, rain or shine, dependably, at low cost.

NEARLY every plant has thousands of square feet of idle roof area, yet their working areas may be starved for floor space.

Using the roof for materials handling by means of an automatic Cleveland Tramrail system can be a big help in relieving a crowded plant. And the roof need not be flat. Even a saw-tooth or gabled roof can be used to support a Tramrail track.

The automatic system illustrated here brought about tremendous savings. It, in effect, joined two factory departments and enabled as efficient an operation as though they were physically adjacent. It reduced the handling cost to the barest minimum because the Tramrail carrier shuttles back and forth without need of attendants. It eliminated other overhead expenses.

Cleveland Tramrail engineers have had wide experience in the design and application of automatic materials handling systems and will be happy to discuss ways of helping you without obligation.

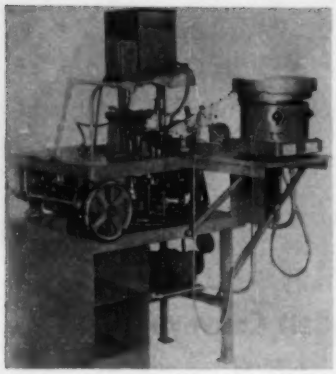
Write for free "Automatic Handling" Booklet.

CLEVELAND TRAMRAIL

Overhead Materials Handling Equipment

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1351 E. 290 ST. • WICKLIFFE, OHIO

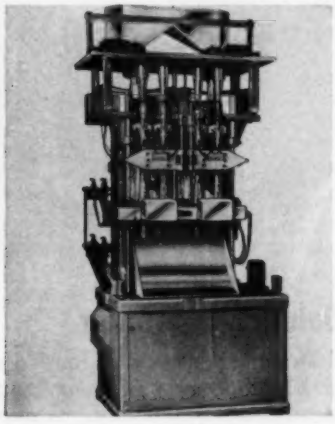
Circle 678 on Page 19



Former/Welder

Equipment automatically produces and assembles crystal diode cat-whiskers at a rate of 3000 units per hour. Model 3189 can handle wire stock ranging from 0.002 to 0.0035 inch. It automatically feeds, cuts, forms, and welds cat-whisker wire or ribbon stock of gold, tungsten, or molybdenum to the end of beaded or unbeaded diode lead wires. Pointed or angled wire ends can be produced with tungsten carbide scissor inserts, and wires may be formed in *S* or *C* shape. A six-position Geneva turret provides precision indexing and a synchronous electronic timer provides uniform welding. **Kahle Engineering Co.**, 3322 Hudson Ave., Union City, N. J.

Circle 405 on Page 19



Pouch Packager

Four filling tubes in machine provide outputs of up to 200 or more pouch packages per minute. Unit can accommodate small pieces, free flowing powders, foods, drugs, liquids, or chemical granules. Either four-seal or pillow type packages can be formed from printed or unprinted roll stock, filled, and sealed. A photocell system provides separate registration for each web, giving positive positioning of package design. Packages up to 2⅜ by 6¾ inches in size can be produced. **Packaging Machinery Div., Food Machinery & Chemical Corp.**, Stokes & Smith Plant, 4992 Summerdale Ave., Philadelphia 24, Pa.

Circle 406 on Page 19

Temperature Monitor

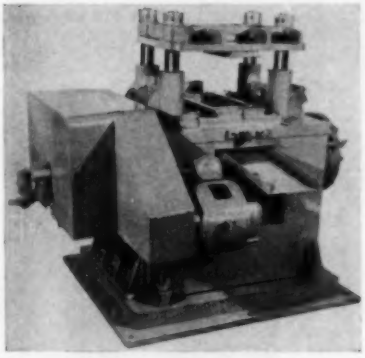
Instrument can simultaneously monitor up to 100 temperature points, with a suitable number of ten-dial panels. When any one of the temperature points being sensed reaches the temperature indicated on its control dial, an alarm is sounded and the critical point is identified by a numbered light on the control panel. The audible alarm can be turned off by a *Reset* pushbutton, but the identifying light remains on as long as the temperature is off-normal. Each channel operates independently, so the unit will continue to sense the other 99 temperature points and will sound an alarm when there is another off-normal condition. Actual temperature of any point can be determined by depressing a *Quiet* button, then manually rotating the appropriate set point dial until the numbered light flashes on. The monitor can provide direct readings on the Fahrenheit scale with an over-all accuracy of ±3 F. **Fischer & Porter Co.**, 303 Jacksonville Rd., Hatboro, Pa.

Circle 407 on Page 19

Tape Input Unit

Unit is designed to adapt company's electronic computer (Model E101) to accept data and instructions from either one of two tape readers. When coupled with standard input unit, "piggy back" unit (at top in illustration) provides completely automatic control of two separate tapes through the computer's pinboard programming unit. Applications for the duplex unit include: Payroll, statistics, utility billing, and scientific data reduction. **ElectroData Div., Burroughs Corp.**, 460 Sierra Madre Villa, Pasadena, Calif.

Circle 408 on Page 19

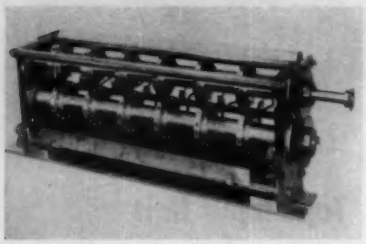


Flying Die Press

Flying die type cutoff and prenotch press for roll formed materials permits the use of coil stock instead of cut lengths. Model 5-D is available in 4 to 120 ton capacities with an operating speed of 300 rpm. Either a flag trip or positive, mechanical runout table can be furnished to requirements. An electrical clutch-brake is furnished on 4 ton units; larger units have air

clutches and brakes. Adjustable height and lateral positioning means are incorporated. **Dahlstrom Machine Works Inc.**, 4227 W. Belmont Ave., Chicago 41, Ill.

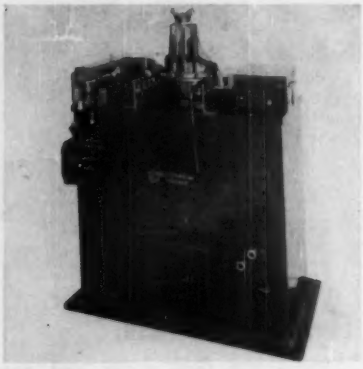
Circle 409 on Page 19



Web Stock Perforator

Machine is used with web equipment, will punch holes in paper and films such as polyethylene, cellophane, and mylar. A side adjustment for centering with the web is provided and the spacing of individual sets of punch and die wheels is adjustable laterally to the web. The machine operates at press speeds, can punch hole sizes of 3/32, 1/8, 3/16, and 1/4-inch. Features of the unit include: Spring loaded, adjustable-pressure regrindable dies; and ball bearing mounted shafts. **Laukhuff-Pratt Mfg. Co.**, 3097 W. Mill Rd., Milwaukee, Wis.

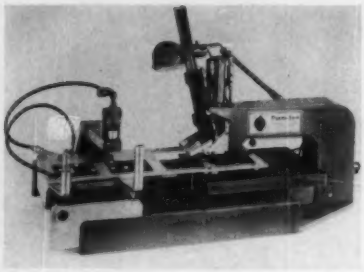
Circle 410 on Page 19



Hydraulic Marker

Horizontal, hydraulic marking machine is adaptable to a wide range of round parts. It is conveyor fed and discharged. In operation, parts are positioned for marking in retractable cradle nests by a hydraulic shuttle feed. After positioning, a hydraulically operated die slide, with lettering tool in the marking position, rolls the legend into the periphery of metal parts. When parts are being marked with consecutive serial numbers, each successive number is indexed automatically on the return stroke of the die slide. The numbering head is engraved with characters from 1 to 0. Other combinations of characters can be furnished for any numbering or marking requirement. Model 465 is powered by a 2 hp, 220/440 v, 3 phase, 60 cycle motor. **Geo. T. Schmidt Inc.**, Dept. C, 4100 Ravenswood Ave., Chicago 13, Ill.

Circle 411 on Page 19



Component Assembler

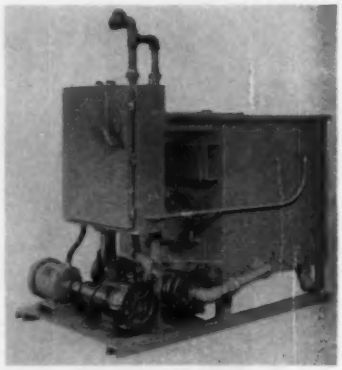
Machine operates on a pantograph principle, can insert components in printed circuit boards. The inserting head of Model PCI is mounted on an arm over a table that can be positioned on X-Y coordinates. Two operating handles permit moving the table within a 12 x 12-inch area. In operation, a production board that is to receive components is placed in position on the table with the board under the insertion head. A template board fixed to the table is then located approximately so that one of its register buttons is under a stylus. Pressing a knob in one of the operating handles then causes the stylus to descend into a tapered hole in the button, locating the production board exactly under the inserting head. A component in the inserting head then has its leads cut, bent, inserted, and clinched beneath the board. Production rate of the machine is 30 components per minute. **Electro-Machinery Div., Design Tool Corp.**, 772 Bergen St., Brooklyn 38, N. Y.

Circle 412 on Page 19

Belt Conveyor

Line of non-slip belt conveyors, designated Series L, is suitable for interfloor movement of goods, for use as a booster in a gravity conveyor line, or for horizontal conveying. The conveyor components consist of: Chain drive for 50 fpm belt speed (1/3 to 1 hp motor), safety release roller, straight or noseover delivery, box frame intermediate sections, gravity wheel feeder, power feeder, adjustable floor stands, truss rail for long spans, adjustable continuous guard rail, and connections for wheel or roller sections. Conveyor is available in 12, 16, 20, and 24-inch belt widths, in 2 1/2 ft increments from a basic 5-foot length. **E. W. Buschman Co.**, Clifton & Spring Grove Avenues, Cincinnati 32, Ohio.

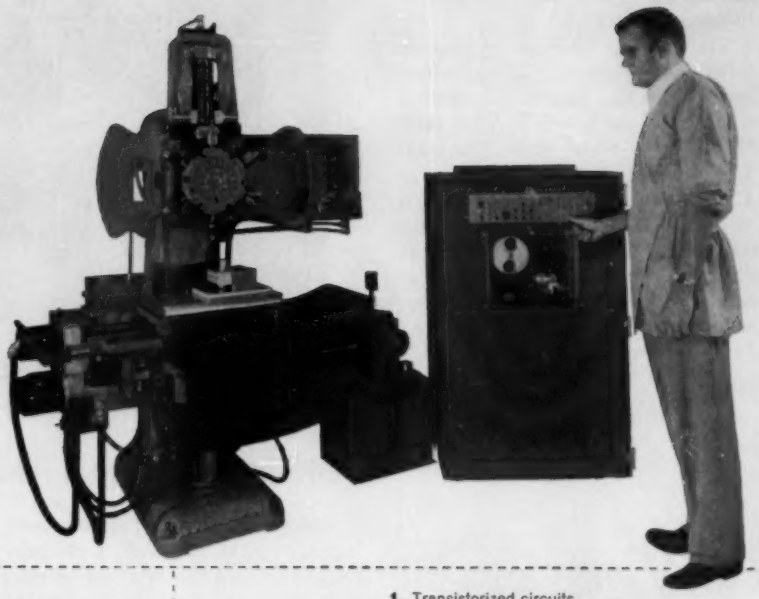
Circle 413 on Page 19



Solution Controller

Designed for use with continuous or bath-type metal washing equipment, plating processes, chemical process systems, and textile bath equipment, electronic system controls the concentration of caustic, acidic, or aqueous solutions. System consists of a concentrate level-setting control, a sensing electrode, a magnetic amplifier, a pump as-

NEW! HUGHES 2-AXIS MACHINE TOOL CONTROL



The new Hughes Machine Tool Control provides you with automatic positioning of a two-axis table plus third axis feed control if desired. Designed for use in drilling, boring, turning, riveting, spot welding, punching, eyelet inserting and other similar operations, the Hughes Control offers you significant tooling and labor savings. It is easily adaptable to new machines or for retrofit.

advantages

1. Simplification of tooling reduces lead time.
2. Precision positioning eliminates expensive tooling.
3. Handling is reduced between operations.
4. High-speed operation reduces the number of machines required.
5. Scrap due to operator errors is reduced.
6. Very large savings are realized in re-run of any given parts order.
7. Eliminates large inventories.
8. Rework of tooling after design changes is replaced by simple modification of machine tape.
9. The new operator produces as much as the experienced operator.
10. Cost estimating is more precise.
11. The inspection burden is greatly eased. All parts are identical.
12. Planning and scheduling is greatly simplified. Many more operations can economically be performed with one machine and one setup.
13. Tape control means the machine delivers high precision work at the same cost as low precision work. Tight tolerances at no extra cost.

advanced features of the new Hughes Products 2-axis machine tool control

1. Transistorized circuits.
2. Mercury-wetted relays eliminate "chatter."
3. Positioning accuracy is ± 0.0005", non-cumulative.
   Repeatable accuracy: ± 0.0002".
   Input resolution: 0.001".
4. Compact cabinet occupies minimum of valuable floor space.
5. Third axis of control easily added at nominal cost.
6. Electronic position transducer insures continuing accuracy and reliability.
7. Digital system assures positive, accurate, high-speed positioning at 180" per minute.
8. Modular construction of plug-in units cuts down-time. Spare unit simply inserted for continuous production.
9. Standard 1", 8-channel Mylar tape used in system.
10. Optical tape reader for precise, high-speed information input.
11. Tape is prepared on Hughes Products unit which is simple to operate and low in cost.

other specifications

Travel	Unlimited, except that the maximum movement per block of tape is 39.999 inches.
Axis Control	Two axes simultaneously.
Drive System	"Creep Traverse Drive Unit" to be attached to preloaded ball bearing leadscrew.
Tape	1 inch, eight channel, opaque, perforated tape.
Tape Reading Time	Less than one second during feed axis movements. Does not add to machining cycle.
Drive System Power	1/4 hp (higher power in special unit).
Resolution	0.001 inch.
Auxiliary Functions	24 bits of information available—programmable as six binary coded decimal digits.
Operation Modes	1) Automatic. 2) Set-up (semi-automatic for tape and program checking). 3) Manual.
Power Requirements	110 volt, single phase. Control plus drive motors require less than 10 amps.

For further information on the Hughes Machine Tool Control...and its application to your specific needs...please write or wire: HUGHES PRODUCTS, Industrial Systems Division, International Airport Station, Los Angeles 45, California.

For export information, write: Hughes International, Culver City, California.

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sembly, a wash tank, and a combination compound and concentrate holding tank.

The sensing electrode accurately measures any change in concentration. When the level of the concentrated solution in the holding tank falls below a preset point, the magnetic amplifier automatically actuates the pump assembly which sprays a wash solution on the dry compound (or liquid concentrate) until the wash tank concentrate is again at the desired concentration level. **Electro Mechanisms Corp.**, 7301 Ridgeway Ave., Skokie, Ill.

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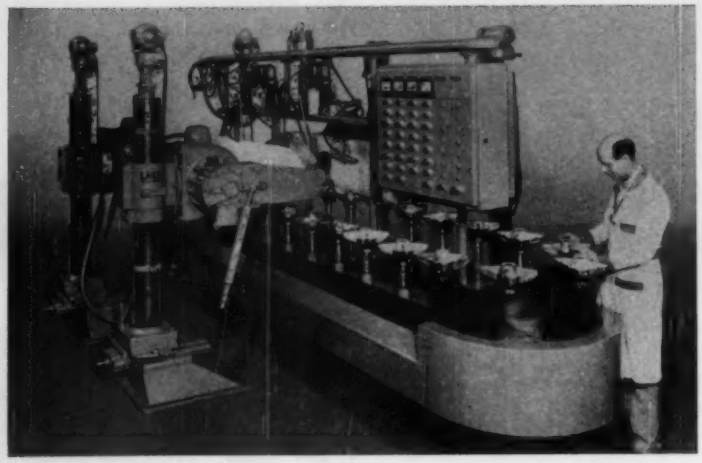

Tape Processor

Tape preparation and editing console automatically verifies and duplicates paper tapes. Console consists of: Numerical keyboard, a control and comparison section with 6-digit decimal readout, two tape readers, and one tape perforator. The tape can be produced in several modes from source data entered at the keyboard or it can be reproduced directly from a master tape placed in one of the readers. Tape verification is accomplished either through keyboard data reentry or through comparison of tapes in the two read stations. Comparison is automatic within the console. Tape widths of 0.687, 0.875, and 1.000 inch are acceptable. Features of the unit include: Tape-to-tape duplication and verification at 60 characters per second, visual display of the keyboard, and automatic error alarm and tape correction. **Tally Register Corp.**, 5300 14th Ave., Seattle 7, Wash.

Circle 415 on Page 19

Polishing and Buffing Machine

Adaptable for polishing and buffing operations, machine is basically an in-line conveyor that moves one-foot long cast iron platens around the periphery of the unit. A motorized chain drives the platens at feed rates from 4 to 29 fpm. Work spindle assemblies are attached to each platen with dovetail mountings. Sprockets on the end of each spindle assembly can be driven in either direction by separate fixed or motorized roller chain arrangements at any position along the conveyor. The spindles can also be provided with camming surfaces to provide preset work motions at any work positions.

Polishing or buffing operations are performed by separate adjustable lathes placed around the periphery of the conveyor unit. Each lathe can be provided with rotating buffs, polishing wheels, or abrasive belt heads to perform the desired polishing or buffing sequence. The lathes are equipped with interchangeable power drives for raising or lowering the wheel heads. In the illustration, the machine is buffing hub cap spinners. Four lathes are performing buffing operations and a fifth lathe is performing a coloring operation. **Acme Mfg. Co.**, 1400 E. Nine Mile Rd., Detroit 20, Mich.

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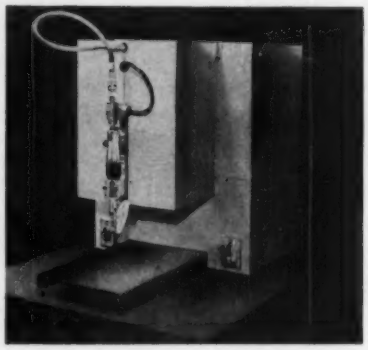
Setscrew Feeder/Driver



Portable driving head can automatically receive and drive setscrews at distances 15 ft or more from the machine at rates up to 2000 per hour. Head can also be clamped in a fixed position for bench use. In operation, a screw is fed to a selector from a rotating hopper. The screw is correctly positioned and is carried from the indexing mechanism by air through a flexible tube to the driving head. The setscrew is then seated to a preset depth or torque by the air-powered head.

For portable use, the head is hand-held. Pressing a trigger on the head cycles the selector and sends a screw through the tube to the head. A clutch mechanism prevents the screwdriver from tightening a screw beyond the preset torque or depth. For stationary use, the head is held in an adjustable mount on the machine. **Socket Screw Div., Bristol Co.**, Waterbury 20, Conn.

Circle 417 on Page 19

Models 400 and 600 Erickson Speed Indexers. Standard index plate provides 4, 6, 8, 12 and 24 positions; special parts provide up to 50 positions on Model 400, up to 100 positions on Model 600. Other models available.

Angular accuracy within 2 minutes... repetitive accuracy in low "tenths" of a thousandth

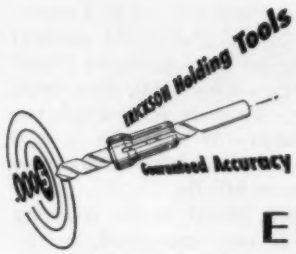
ERICKSON INDEXERS–

the economical way to smash automation bottlenecks

Even the most elaborate automatic production line can bog down *expensively* without rapid and accurate automatic parts positioning.

That's where Erickson Indexers really pay off. For you can interlock them into your production set-up with micro switches and solenoid valves. The hardened and ground lock pin operates in conjunction with the actuating mechanism to assure *positive positioning and angular accuracy within 2 minutes of a degree.* (Repetitive accuracy is no indication of angular accuracy. Erickson holds repetitive accuracy in low "tenths" of a thousandth.) And Erickson Indexers can maintain this great accuracy because their adjustable, self-contained shock control unit delivers a cushioned rotary load to the mechanism, thereby reducing wear.

Speed to keep lines moving . . . accuracy to reduce rejects . . . long life to cut maintenance and capital investment – all add up to Erickson Indexers, the *economical* way to smash automation bottlenecks.



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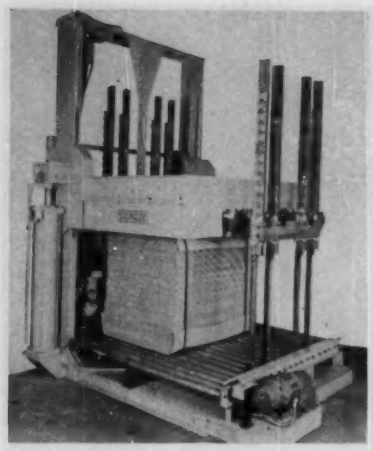
Circle 680 on Page 19



Compression Strapper

Applicable for compressing bales of cardboard containers, equipment also feeds, adjusts the tension of, and seals steel straps automatically. Machine is available with platen pressures from 6000 to 16,000 lb with either a pneumatic or hydraulic loading system. Equipment can easily be incorporated in production lines, with finished bales removed by conveyor for shipment or storage. **Signode Steel Strapping Co.**, 2600 N. Western Ave., Chicago 47, Ill.

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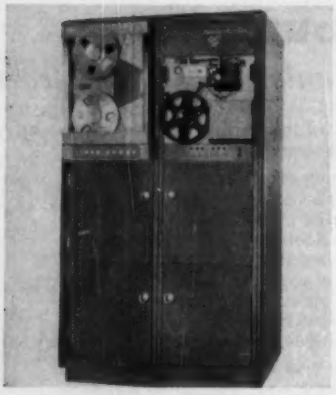
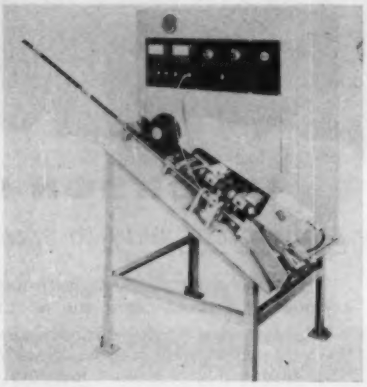


Tape Converter

Unit can convert data that is on magnetic tape to standard teletype paper tape. The data can be produced by any computer which has a six-bit parallel code, plus a parity bit and serial by character. The input and output data, although in a different code, are completely identical in content. Magnetic tape data is accepted by the converter in the computer code by a tape unit that is compatible with the computer tape. The conversion operation is initiated manually, but proceeds automatically until the end of the input tape data. A high-speed perforator, punching at a rate up to 240 characters per second prepares the paper tape output. Control over the format is provided without computer programming. A plug-board permits insertion of carriage returns, line feeds, and blanks. Figure and letter shifts are automatically inserted by the converter whenever the output calls for a number-to-letter (or vice versa) translation. Feature of Model D101 is the self-checking facilities which cause a reread when an error is detected. If the error continues, light indicators on the control and front panel show the location. Replacement can be made without interrupting the operation of the unit. **Digitronics Corp.**, Albertson Ave., Albertson, L. I., N. Y.

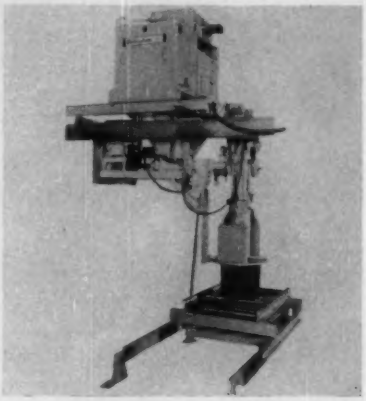
Circle 419 on Page 19



Inspection Machine

Machine can check and sort up to 2200 valve guides per hour for out-of-roundness and other diametral characteristics within a tolerance of 0.0005-inch. Parts are automatically segregated into acceptable and reject categories by the machine. The absolute sizes of parts do not affect the inspection operation, since response is to size changes during gaging. A standard electrostatic gage head and electronic gaging modules are used in the gaging section of the machine. Parts may be fed in proper orientation directly from a centerless grinder, or they can be fed manually down a gravity chute leading to the gaging and classifying stations. **Industrial & Automation Div., Radio Corp. of America**, 12605 Arnold Ave., Detroit 39, Mich.

Circle 420 on Page 19



Drum Filling System

System can automatically weigh out materials and fill drums or valve bags at a rate up to 600 lb of material per minute. It can handle crystalline chemicals with densities up to 40 lb per cu ft in fine powder form and 100 lb per cu ft when in free-flowing form.

In operation, an empty drum is delivered to the filling position each time a gravity roller conveyor is raised by an air operated lift mechanism. As the conveyor returns to its lowered position, air operated clamps secure the empty drum in the filling position. A filling tube then descends over the empty drum. As it does so, a drum cover mates with the top of the empty drum to form a seal that prevents the escape of material dust. A scale then weighs out and delivers to a receiving hopper an amount of material equal to the quantity to be placed in the drum. Depending upon drum capacity, the scale may weigh out this quantity in from one to four increments. Each increment may weigh up to 100 lbs.

Material placed in the receiving hopper is next compacted, or deaerated, by a packer and then placed in the filling tube. From the filling tube, the material flows into the drum. An air operated, vibratory type packer shakes down

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Circle 681 on Page 19

the material in the drum. To complete the filling cycle, the roller conveyor returns to the raised position to advance another drum into filling position. The filled drum then proceeds to a station where a lid is applied. For valve bag filling, the setup is the same except that the drum cover is removed. **Richardson Scale Co.**, Clifton, N. J.

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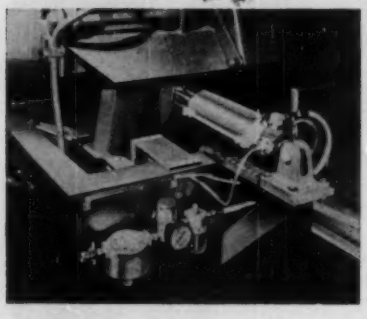

Saw Feeder

Automatic blade feed unit for cut-off saw includes a valve-in-head air cylinder which actuates a complete cutting cycle, both advancing and returning the cutting head automatically. When a control valve is operated, the pneumatic piston advances the saw blade through the stock at a uniform rate, then automatically returns the saw arm to *Rest* position. By means of a manual override control, the cycle can be interrupted at any point and the saw arm returned to *Rest* position. Unit is available with 6 or 12-inch stroke pistons, can be used for other applications such as stock feeding and drill head cycling. **Production Machinery Inc.**, P. O. Box 322, Oakton Station, Des Plaines, Ill.

Circle 422 on Page 19

Numerical Positioner

Control console of numerical positioning equipment houses a tape reader, manual coordinate-setting dials, numerical readout indicators, electronic equipment, and power supplies. The tape reader is provided with tape spooling equipment. Feed and take-up spools accommodate 200 ft of tape—sufficient for 600 three dimensional position movements. Information space is allocated on the tape for controlling machine functions other than positioning.

The electronic equipment is in the form of plug-in circuit cards; only four types of cards are utilized. An automatic error system actuates an indicator lamp which identifies faulty channel. A transistor decimal counter with a continuous ternary checking circuit keeps a record of the position of the machine slide from an arbitrary datum. The datum can be changed at any time and set to correspond to any point on the table. A direction discriminator decides whether the co-ordinate in the counter is higher or lower than the demanded position, and selects the direction of movement to bring the table position into coincidence with the setting. In event of a failure, the equipment will automatically stop and will not function until the defective circuit card has been replaced or repaired. **Electronics Div., Ferranti Electric Inc.**, 95 Madison Ave., Hempstead, L. I., N. Y.

Circle 423 on Page 19

Tube Tester

Instrument tests corona tubes, provides the results in the form of both punched cards and automatically plotted *X-Y* graphs. Accuracy is within 0.1 per cent. The test set incorporates a linear swept power supply. Sweep linearity is maintained over the entire range of two bands providing 20-2000 v and 500-15,000 v. Up to 5 ma can be provided with a maximum of 30 mv peak-to-peak ripple and sweep speeds of 30 to 300 v per second can be set on the 2000 v scale. An environmental chamber permits temperature response analysis. Nine separate tests are made under push-button control and provisions are made for visual monitoring during each test. **Briggs Associates Inc.**, 10 Dekalb St., Norristown, Pa.

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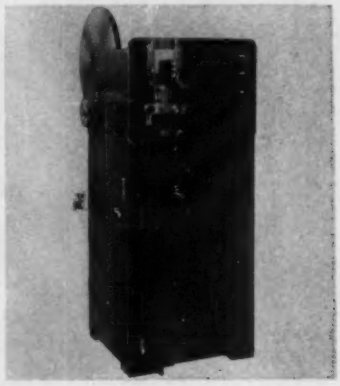


Armature Processor

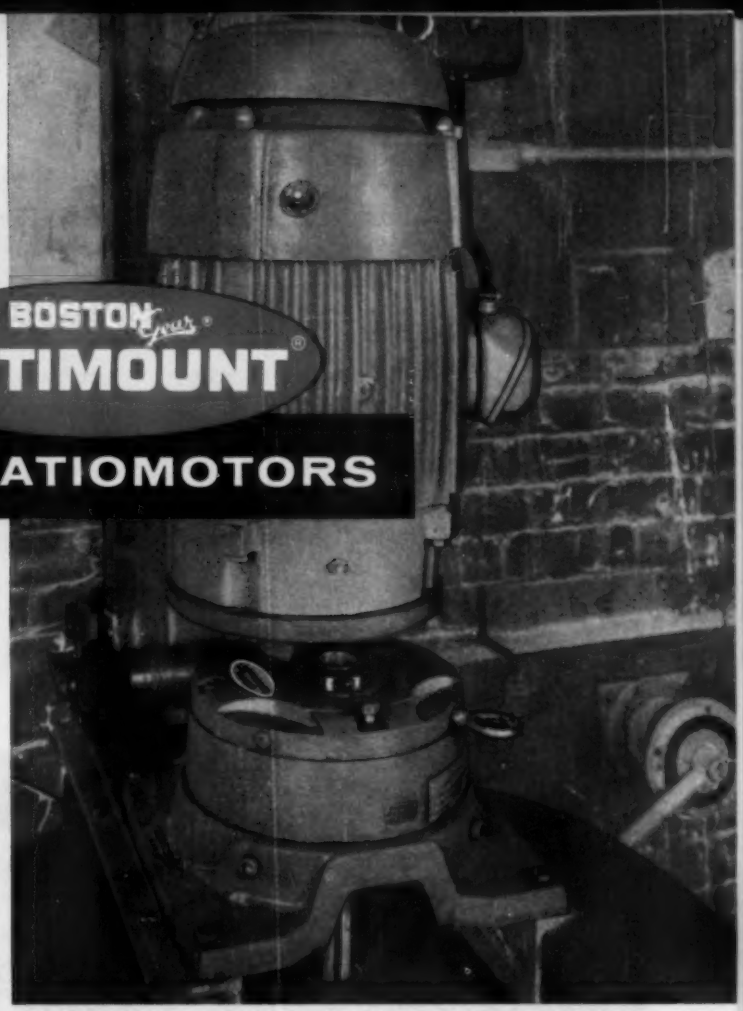
Used in the manufacture of armatures, wedge and cell machine can insert at the rate of 2 slots per second with a 2 second load time. Eleven-slot armatures can be celled or wedged at rates up to 480 armatures per hour. Tooling change-over on cell inserters requires only 12 minutes, on wedge inserters only 7 minutes. In operation, a foot lever opens a pair of jaws. An armature is placed in the jaws and when the foot lever is released, the jaws automatically close. A *Start* push-button is depressed to set the inserter into operation. The inserter automatically orients an armature slot, feeds and forms paper, cuts off an insulator to specifications, pushes the insulator into the armature slot, and indexes for the next slot. This cycle is automatically repeated until all the slots are insulated, then the inserter turns off. **Possis Machine Corp.**, Dept. 100, 1645 Hennepin Ave., Minneapolis, Minn.

Circle 425 on Page 19

When the job calls for
"~~gearhead motor~~"

cost-wise designers specify

BOSTON Gear®
OPTIMOUNT®
HELICAL GEARED
RATIOMOTORS



VERTICAL BASE MOUNTED OPTIMOUNT RATIOMOTOR drives agitator blade shaft on pigment mixers in coated textiles plant. Manufacturer says: "OPTIMOUNT adaptability permitted simplified, efficient design for our specific needs . . . at a much lower cost for the complete installation."

Add up the SAVINGS and see why . . .

YOU SAVE DESIGN TIME. Optional mounting gives full scope to your designing skill. Drive arrangements are not restricted by the mounting limitations of conventional gearhead motors.

YOU ELIMINATE EXTRA COST OF SPECIALS. With OPTIMOUNT Ratiomotors FROM STOCK, you can meet hundreds of unusual drive conditions that would require "specials" in conventional gearhead motors. You save the delay and extra cost.

YOU REDUCE PARTS COST. Since OPTIMOUNT offers a choice of many output shaft positions, you can design for direct lineup — and eliminate extra couplings, bearings, and other parts needed to "hook up" a conventional gearhead motor.

YOU SPEED PRODUCTION. Order the OPTIMOUNT you need with a phone call to your local Distributor, for delivery FROM STOCK. You can start production without delay, maintain schedules, and avoid big inventory expense.

YOU SIMPLIFY SERVICING. All OPTIMOUNT components are standardized stock parts — available promptly from over 100 BOSTON Gear Distributors throughout the U. S. and Canada.

Ask your BOSTON Gear Distributor for complete information. Boston Gear Works, 95 Hayward St., Quincy 71, Massachusetts.

Meet any in-line drive mounting conditions with STANDARD STOCK models

Vertical or horizontal base mounted — for any floor, wall, or ceiling mounting position — choice of many shaft positions in either base — single or double reduction helical gearing — for ⅓ to 10 hp drives. Sold also without motor, ready for attachment of separately purchased motor of your choice.

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Horizontal base mounted

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BOSTON Gear® DISTRIBUTOR
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Circle 682 on Page 19

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You, too, can have the benefit of well-planned mechanized handling in **your** plant. Mathews Engineers would like to work with you in developing a conveyer system which would create a smooth flow of **your** product through processing, warehousing, and shipping.

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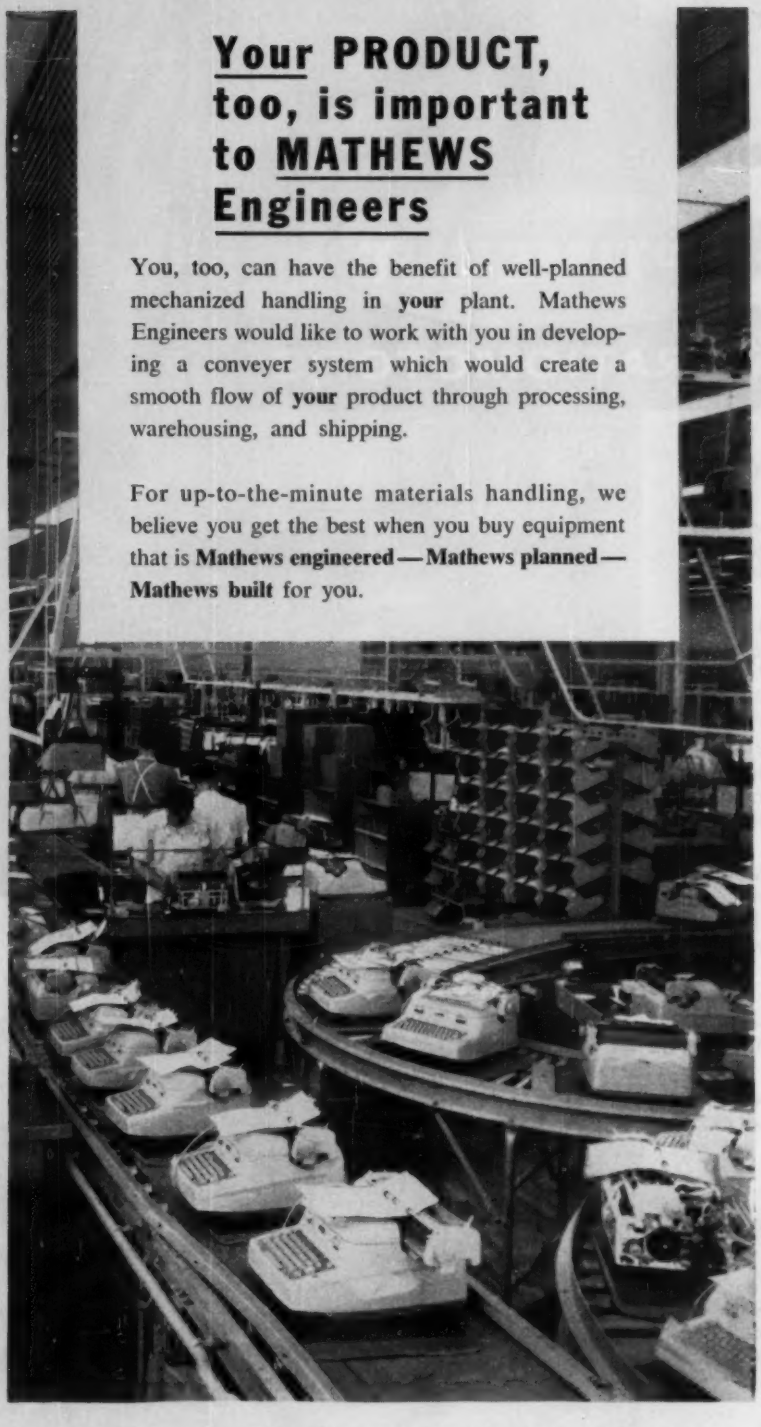

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CANADIAN DIVISION . MATHEWS CONVEYER COMPANY, LTD., PORT HOPE, ONTARIO.

MATHEWS

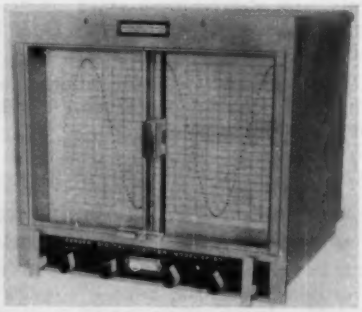
Over Fifty Years of Leadership in Mechanized Handling

Circle 683 on Page 19

Multitrack Recorder

Seven-track instrumentation recorder features one megacycle frequency response per track, using a ½-inch magnetic tape. Unit has a tape speed of 120 ips, allows 12 minutes of running time with standard 1 mil tape. Reproducible timing accuracy is 0.005 per cent. Peak flutter and wow specifications are 0.1 per cent or less, measuring all components from 0.1 cycle to 4000 cycles. Starting in 4 seconds from rest to full tape, Model CV-100 possesses an input impedance of 93 ohms, with 0.1 v peak-to-peak input voltage required. Output signal level is 2 v at 93 ohms impedance. **Mincom Div., Minnesota Mining & Mfg. Co.**, 2049 S. Barrington Ave., Los Angeles 25, Calif.

Circle 426 on Page 19



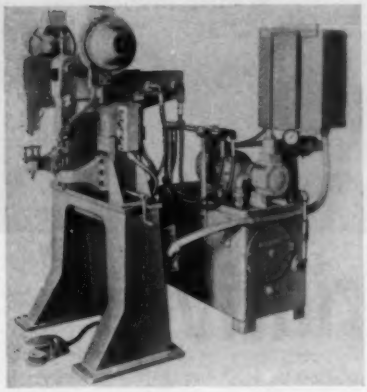
Digital Data Plotter

Instrument can be supplied to accept *X-Y* data in any normally used digital format such as binary, decimal, binary coded decimal, or analog. The digital to analog conversion is made by relay matrices and precision bridges, mounted on a removable, plug-in panel. Model GP-1 includes two high-speed servo systems which position a

printing mechanism according to the binary coded *X* and *Y* input signals; two digital-to-analog converters, one each for the *X* and *Y* signals; a plot and computer acknowledge circuit; and power supplies. The plot and computer acknowledge circuit actuates printing solenoids after the printing mechanism has been properly positioned by both the *X* and *Y* servo systems.

The basic mechanical system consists of a print mechanism and carriage with associated drive motors, plotting table, and a vacuum holdown system. The carriage is driven in the X direction through a flexible cable. Travel in the Y direction is accomplished by positioning the print mechanism along the carriage by means of a double drive cable linkage. The print wheel can be made to index to provide up to six different symbols. **Gerber Scientific Instrument Co.**, 89 Spruce St., Hartford, Conn.

Circle 427 on Page 19



Dual-Head Riveter

Hydraulically powered riveter is adaptable to a wide range of applications. Model HDR includes two riveting stands with 8-inch throat depth. Each stand is adjustable to spacing from 1½ inches minimum to 18 inches maximum, center to center. Unit is tooled to set two ¼-inch diameter solid steel rivets that are gravity fed from two 10-inch diameter hoppers. The operating cycle is approximately 0.8 second at 420 psi oil pressure when setting two ¼-inch rivets. Maximum operating pressure is 1000 psi. **Tomkins-Johnson Co.**, 2425 W. Michigan, Jackson, Mich.

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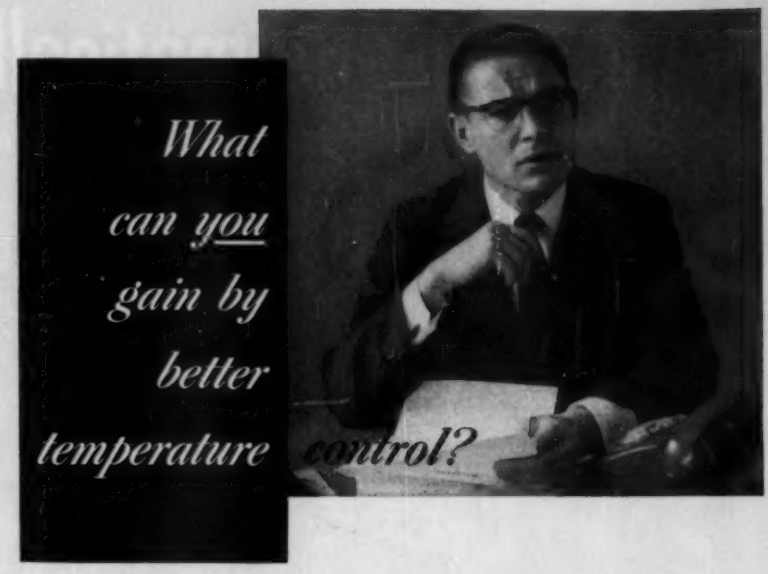

If temperature is a factor in *any* step of your overall operation, quality of its control can affect *several* steps far more than you might expect. And, from our experience with countless applications that may be considered "satisfactory," control is rarely as good as it can be...

Temperature control can be more precise and consistent. It *can* reduce work-stoppage and rejects. It *can* increase volume and maintain quality. It *can* simplify some steps and materially cut costs.

Use the know-how of our world-wide service force to evaluate your potential in temperature control. Free consultation plus complete selection of instruments to suit your individual situation—Veri-Tell Indicators, Gardsman Controllers, Marksman Recorders, our own Thermocouples and accessories.

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Any combination of our instruments, complete with accessories and wiring, is factory-installed in a compact steel cabinet to suit your situation. At the other extreme, we offer a complete selection of our own thermocouples and accessories priced and ready to ship at your convenience. Phone your West consultant (see Yellow pages) or write Chicago office for Bulletin CS or for COM digest-catalog of line.

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Circle 684 on Page 19

liquid level automatically controlled

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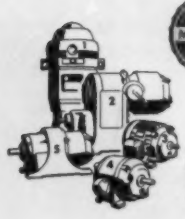
using adjustable speed U.S. Varidrive

with VARITROL *automatic speed control*

This U.S. Liquid Level Control System adjusts pump motor speed to maintain constant level in open tanks such as those used in food, petroleum, sewage or chemical processing industries. Pumping is continuous. Level can be held as close as ¼" when necessary. No electronic circuitry, no special technicians required to maintain and operate equipment. Many other U.S. controlled speed systems with U.S. Varidrives regulated by Varitrol are available for production involving gases, liquids or solids. Write for brochures.



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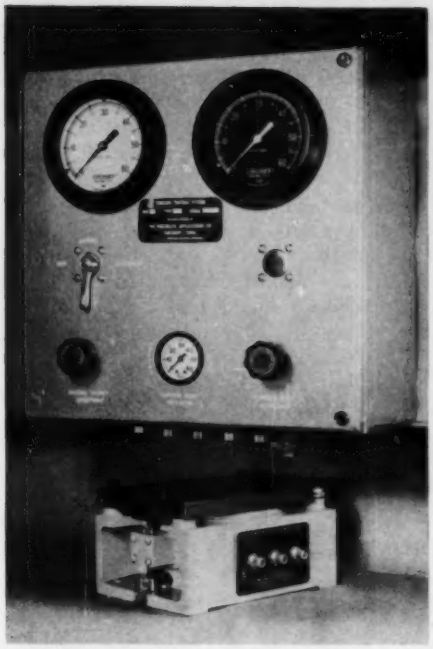
Circle 685 on Page 19

AUTOMATION

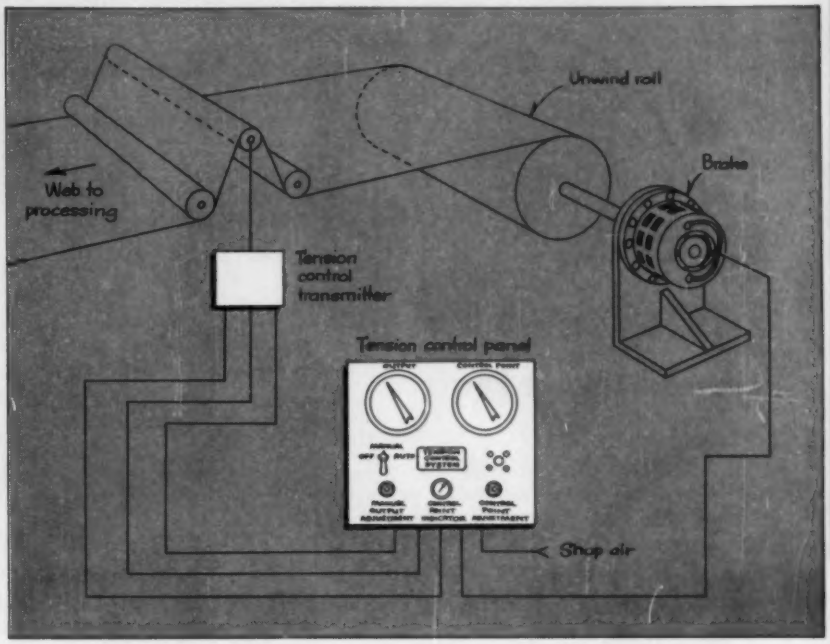
new components

For detailed information and literature, use card page 19.

Parts, elements and devices designed for creating more automatic systems.



Automatic tension controller includes an instrument panel and a transmitter. The panel is adaptable to either face or flush mounting.



Drawing shows a typical unwind application. The unit can be used on any continuous process handling webs or stands where the material can pass across an idler roll or pulley.

Instrument Controls Tension on Winding Operations

TENSION controller is applicable on any continuous process handling webs or strands where the material can pass across an idler roll or pulley. Unit, designed by **Pneumatics Applications Co.**, 75 Meadow Plains Rd., Simsbury, Conn. provides pneumatic control signals to regulate tension. It maintains constant tension in the web leaving the unwind roll by applying proper brake pressure to the center bar; it regulates tension in webs traveling through a process by applying precise braking action to hold-back rolls; and it controls tension in a web running to a winder by regulating a pneumatic slipping clutch, variable speed drive, or variable speed motor.

In operation, force due to tension of material passing over a specially pivoted roll is transmitted through a pillow block at one end of the roll to the hinged cover of a transmitter unit. This force on the cover of the transmitter is opposed by a force piston which functions as a reference standard. If the tension forces exceed or drop below the desired value, the force piston operates a valve which, directly or through booster action, modulates a controlled air flow to the control mechanism and restores tension to the correct value. Piston travels only 0.005 inch for full stroke. Instrument is supplied for 60 psi service, with shop line pressure not exceeding 150 psi. The automatic output signal can be any value desired from approximately 3 psi to 100 psi. Consumption is approximately ½ cu ft of free air per minute.

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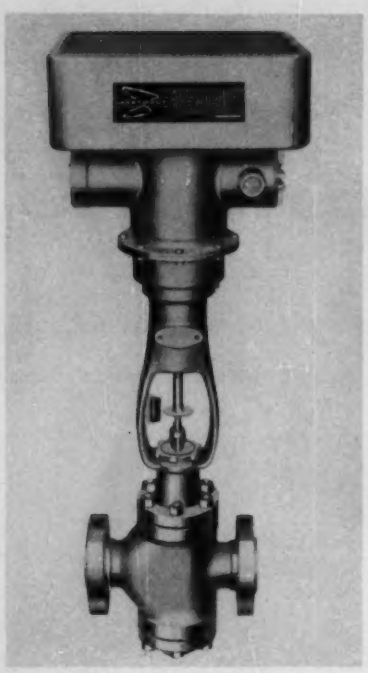


Actuator Driven By Vapor Power

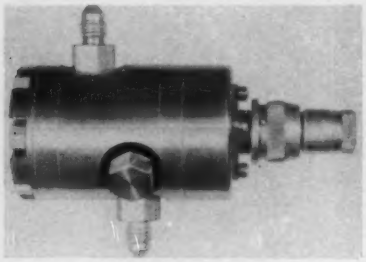
Designed for use with electronic control systems, thermally driven actuator has only two moving parts. Its construction permits stroke and zero adjustments, and provides full operating thrust with low internal pressures. An electrical resistance strip heater vaporizes a liquid at a continuous rate. The pressure of the vapor drives a diaphragm against the valve actuating stem. Positioning control is accomplished by varying the heat-release from the system. A valve regulates the flow of vapor to a heat-exchange surface where a second liquid (Freon) transfers the heat to an ambient-exposed condenser. A moving force coil, energized by the controller signal, and coupled to a mechanical feedback arrangement, controls the heat-release valve.

When the heat-release rate is decreased, vapor pressure against the diaphragm increases, driving the actuating stem downward. When the heat-release rate is increased, the reduced vapor pressure allows the diaphragm to contract, causing an up-stroke of the actuating stem. Actuator develops 300 lb of thrust and has an adjustable stroke span of 0.5 to 1.5 inches. Response speed is 0.1 of an inch per second. **Swartwout Co. Inc.**, 18511 Euclid Ave., Cleveland, Ohio.

Circle 430 on Page 19

Pressure Transducer

Electromechanical device for sensing static and transient pressures in fluids or gases can operate directly into conventional servo systems for readout, recording, telemetering, automatic control, and data reduction. Transducer can withstand a differential overload of 150 degrees of full scale and line pressures to 10,000 psi. Location of the ports provides an interchangeability of fittings at 60, 120, and 180 degrees, and for bleeder valves when liquids are used. Model PDH-4 has a sensitivity of 100 mv/v/fs and a



linearity of ±1 per cent. Model PDH-4C has a 50 mv/v/fs sensitivity and is temperature compensated to 0.01 per cent per degree F. Input voltage at 400 cps is 10 v ac optimum to 24 v ac maximum. Impedance is 300 ohms to 1000 ohms, phase shift 10 degree maximum, with continuous resolution. Unit is available in seven styles with pressure ranges from 0-50 to 0-5000 psi, in gage and differential types. **Crescent Engineering & Research Co.**, 5440 G N. Peck Rd., El Monte, Calif.

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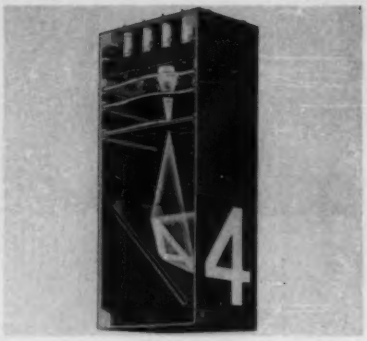
Digital Readout

Designed for applications where depth space is a factor, 90-degree digital readout receives the desired digit from the top of the unit and displays the digit on the front viewing screen via a mirror. Feature of the readout is a condensing lens



which contains twelve individual positions, with the desired digit or characters printed on them. When one of the twelve lamps at the top of the unit is lighted, the lamp projects the corresponding digit through the condensing lens and the projection lens to a mirror which deflects the image 90 degrees onto the viewing screen at the front of the unit. The size of the digit displayed is 3¾ inches high by 2 inches wide. It can be viewed from over 100 ft away. All wiring is done from the top of the unit. **Industrial Electronic Engineers Inc.**, 3973 Lankershim Blvd., North Hollywood, Calif.

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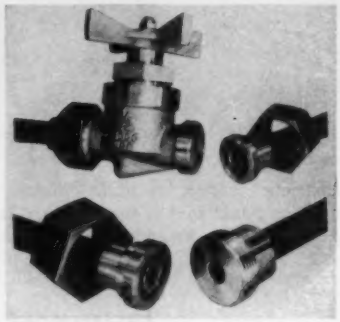

High-Pressure Fittings

Line of O-seal valves and fittings is designed for pressures of 5000 psi or more and temperatures ranging from −20 to 275 F. Included in the line are globe, angle and relief valves, check valves, nuts, tailpieces, threaded pieces, adapters, plugs, and reducing inserts. Tailpieces and threaded pieces are available for socket welded, brazed, or pipe threaded attachment to the line. Positive sealing is provided by an O-ring inserted in the tailpiece. The valves or any portion of the piping

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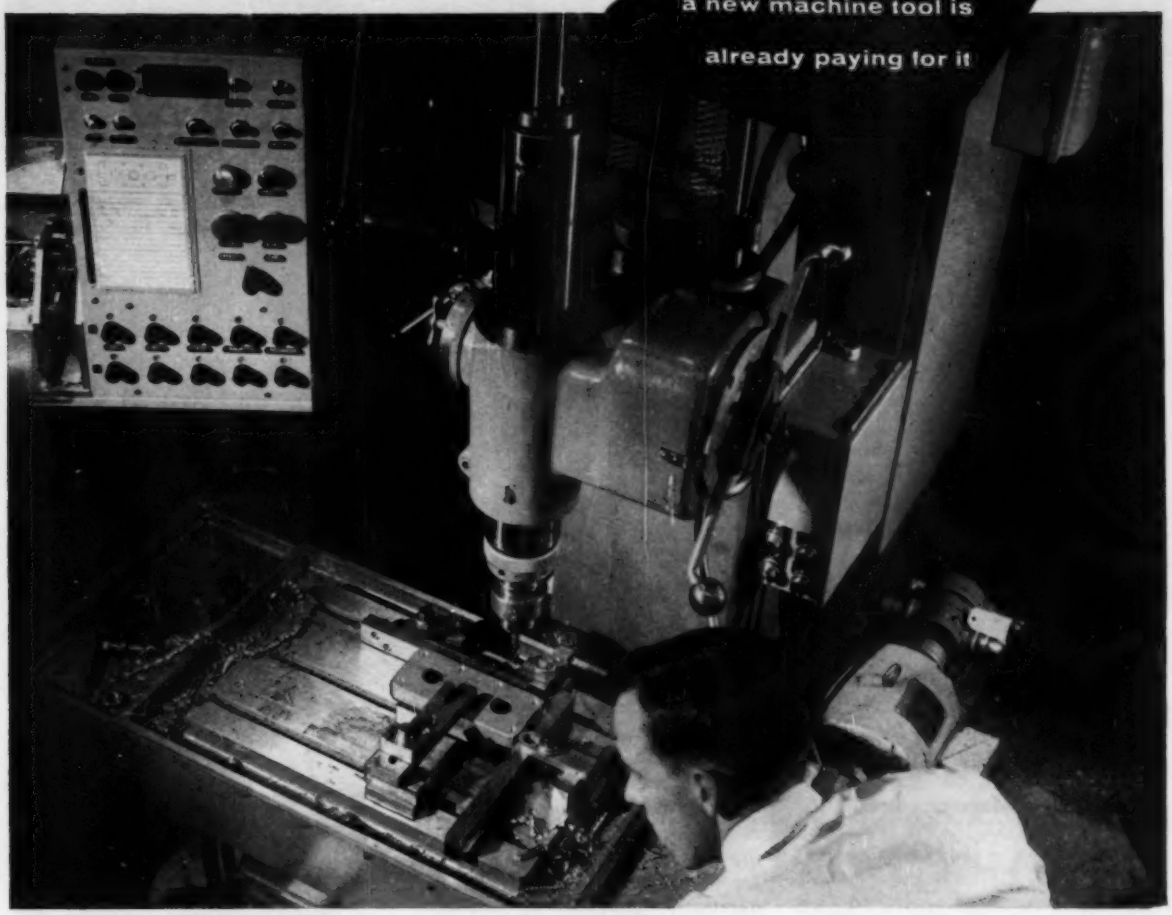
the man who needs a new machine tool is already paying for it



Numerical control positioning eliminates jigs – saves time

The J&L Numerically Controlled Positioning Table quickly and accurately positions work pieces to an accuracy of ±.001″ — without jigs. And it can do it economically with any lot size down to a single piece.

For instance: in one installation, where precision parts previously had been machined on a conventional spacing table, J&L's new equipment achieved cycle time savings of six minutes per piece and set-up savings of over 116 minutes per set-up, or a total savings of 6.95 hours on a lot of 50 pieces.

In another plant, the cost of building $4,000 worth of jigs was eliminated during the first six weeks of operation. And in still another operation, the positioning table not only reduced set-up and cycle time, but also eliminated the storing, handling and maintenance of $29,000 worth of jigs.

You can get in on this kind of savings too. Write to Jones & Lamson Machine Company, 536 Clinton Street, Springfield, Vermont.

Turret Lathes • Fay Automatic Lathes • Milling & Centering Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

Circle 686 on Page 19

can be replaced or relocated without springing or cutting the line. **Combination Pump Valve Co.**, Dept. 502, 851 Preston St., Philadelphia 4, Pa.

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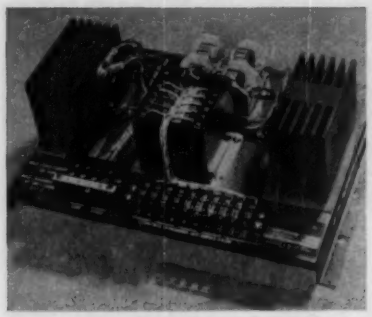

Power Control Unit

Device is composed of solid state thyratrons and a control amplifier, is suitable for applications where adjustable voltage is required, for dc motor speed control, or for heat control in industrial furnaces. Requiring only power and load connections, the unit can be controlled in an open or short circuit mode of operation from a variety of signal sources. Up to three kilowatts can be controlled and the unit will provide a solid state system from logic input to power handling output. It is rated for 120 v, 60 cycle supply. **Control, Div., Magnetics Inc.**, Butler, Pa.

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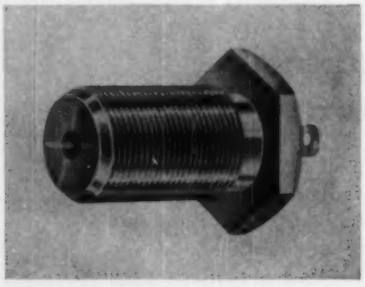
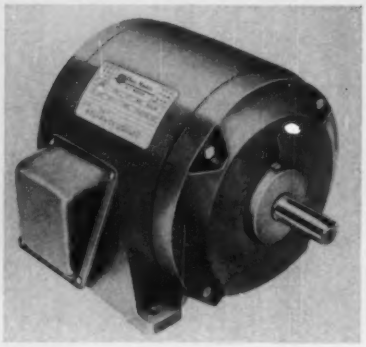


Pressure Switch

Line of electronic pressure switches is capable of switching electrical circuits in response to pressure changes in hydraulic fluids, fuels, or other gases or liquids. The switch is isolated from the pressure media and can be used as a warning indicator in ground check-out systems; or to monitor industrial processes where pressure leakages present a safety or health hazard. The small size of Model 419 permits it to be mounted directly on pressure fittings or built into pressure fitting hardware. Switch is spst, normally closed. Pressure range for the switch is 1 to 500 psig; overpressure without shift, 3000 spig; operating temperature range, −65 to +165 F. **Bourns Inc.**, P. O. Box 2112, Riverside, Calif.

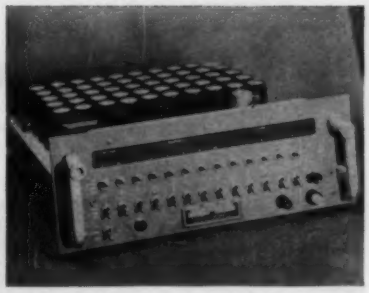
Circle 435 on Page 19



AC Motor

Line of integral horsepower ac motors is available in sizes from one through 250 hp in protected (open), weatherproof, totally-enclosed, corrosion-proof, and explosion-proof enclosures. A feature of the motor is the low inertia, fast accelerating rotor. The rotor is dynamically balanced to movement tolerances of 0.0002 of an inch. This combination of low inertia rotor and increased accelerating torque with double-end ventilation allows frequent stops and starts without overheating. The cast-iron frame protects the motor from dripping or splashing liquids. It has a 40 C temperature rise, with a 15 per cent service factor. Lubrication features include double-shielded ball bearings and a metering plate which automatically regulates the flow of just the right amount of grease to the bearings as needed. The motor is designed with polyphase, ball bearing, vertical, and horizontal mounting arrangements. **Reliance Electric & Engineering Co.**, 24701 Euclid Ave., Cleveland 17, Ohio.

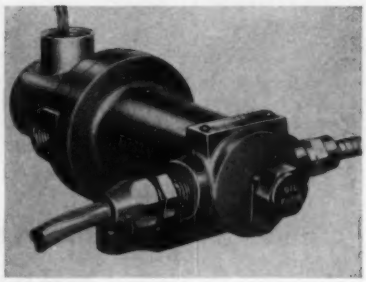
Circle 436 on Page 19



Time Reader

Magnetic tape search unit automatically compares the timing or index track of a magnetic tape with switches set to designate the beginning and end of tape sections of interest. At these times, control signals are generated to effect printout or other desired action. Feature of Model 1060 is a presenser which generates *Start* and *Stop* signals precisely at the beginning of a frame of interest and prior to reading time or index code for that frame. Unit is composed of transistorized, plug-in modules which are mounted with the power supply on a chassis. **Vitro Laboratories**, 200 Pleasant Valley Way, West Orange, N. J.

Circle 437 on Page 19



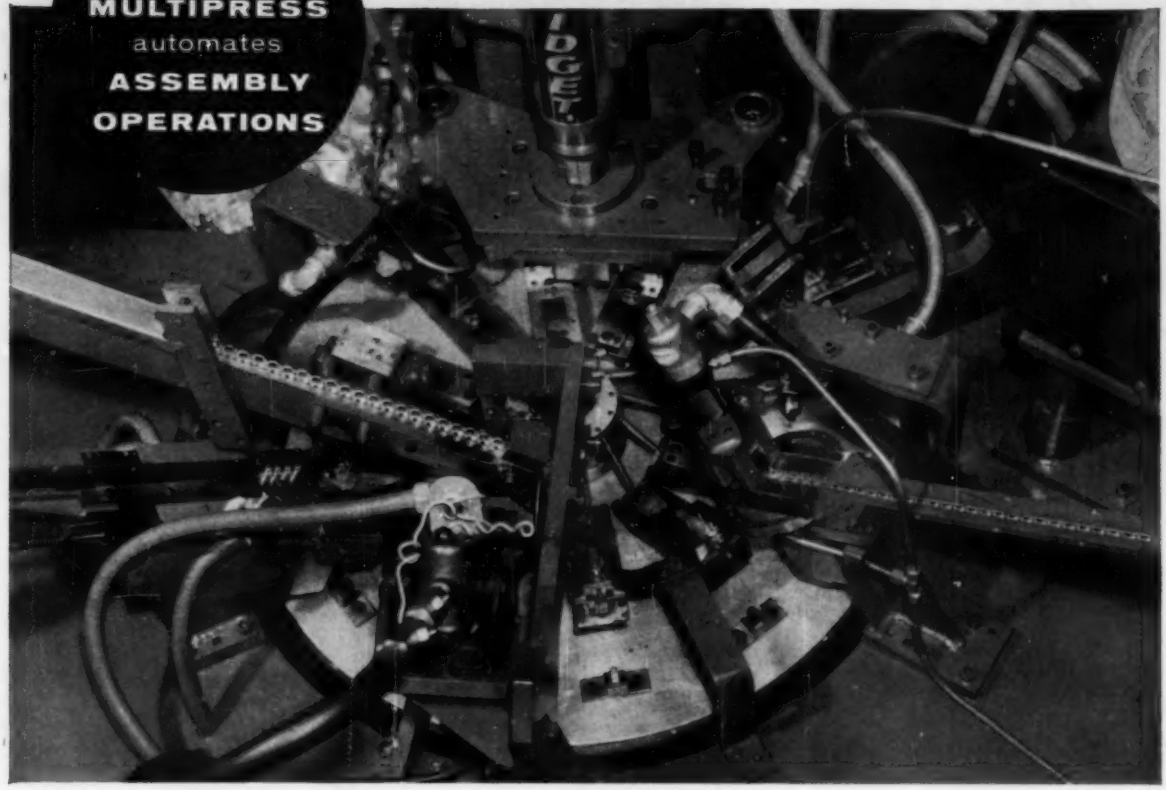
Liquid Dispenser

Unit is designed to automatically dispense oils, light grease, liquid soaps, tap lubricants, glycerine, and other liquids in predetermined volumes. Dispenser has a 36-inch flexible tube and nozzle, is available separately or with a 1-gal reservoir and actuating switch. Operating pressure is 30 psi minimum and 150 psi maximum. It is rated for 115 or 230 v, 50 or 60 cycles. **Logansport Machine Co. Inc.**, Logansport, Ind.

Circle 438 on Page 19

How **DENISON MULTIPRESS** automates **ASSEMBLY OPERATIONS**

45 assemblies-per-minute *are produced on this 1-ton Denison hydraulic Multipress and automatic index table at the Unique Balance Division, S. H. Pomeroy Company, Dubuque, Iowa.*



MULTIPRESS assembles and inspects complex 4-part components

...at a rate of 2700-per-hour

With this Denison hydraulic Multipress and feeding devices, production assembly of complex units has been increased and costs reduced considerably.

Completely automatic, the particular operation shown assembles and inspects the four-part assemblies at a rate of 45-per-minute...*2700-per-hour.* Any defective assemblies are automatically rejected. The operator has only to supervise the equipment and load component hoppers.

The automatic operation shown is typical of how multi-component assembly operations can be simplified with Denison hydraulic Multipress and simple tooling. The Denison field man near you can help analyze your work and demonstrate how you can duplicate these savings in your plant. Write for the Denison catalog describing the full line of Multipress units for your work.

4-part assembly *of spring tension unit for sash balances, used on double-hung windows to replace conventional sash cord and weight.*

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DENISON HydrOILics

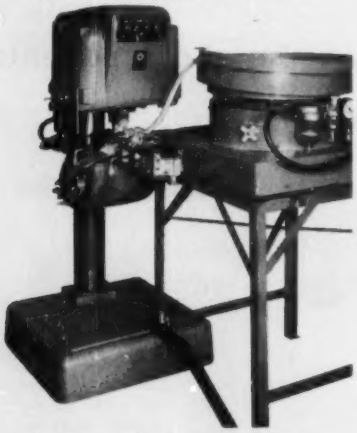
HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

Circle 687 on Page 19

HIGH SPEED *Markers*

Model 2601 marks round shapes as fast as they can be fed. Rotating table delivers parts to marking die — uses roll action for precision marking at minimum pressures.

Model 2620 illustrated with hopper feed for continuous automatic operation. Suitable for tubular or solid rounds.

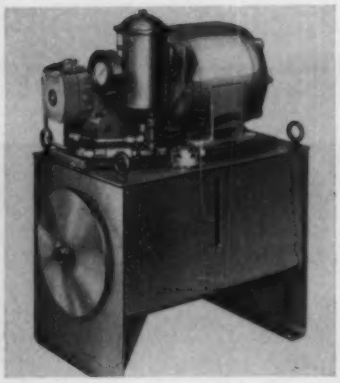


We have illustrations of many hundreds of special marking applications.

Write for further information stating your requirements.

JAS. H. MATTHEWS & CO.
3962 FORBES AVENUE
PITTSBURGH 13, PA.

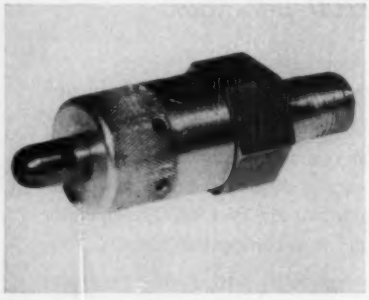
Circle 688 on Page 19



Hydraulic Power Unit

Designed for industrial machine applications requiring low hydraulic horsepower, unit will provide hydraulic power and control for operations such as gaging, transferring, rollover, elevating, indexing, chuck, and clutch. The ten gallon reservoir is equipped with cleanout covers, fluid level indicators, a combination breather and filler, removable baffle and bottom drain plug. Optional features include a return line filter with a bypass check valve, a pressure line bypass filter, an extra breather, extra oil level indicators, and permanent magnets for the removal of metallic particles from the fluid in the reservoir. **Vickers Inc., Div., Sperry Rand Corp.**, 1400 Oakman Blvd., Detroit 32, Mich.

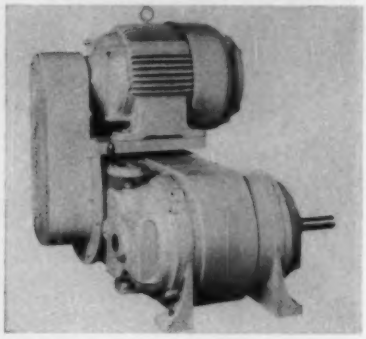
Circle 439 on Page 19



Poppet Valve

Suitable on air operated, automatic machine tool equipment, poppet valve is designed for use as an energizing medium for pilot operated air control valves. It will release a measured amount of air from the pilot chamber of the air control valve, upsetting a static pressure balance. This causes a movement of the valve spool which in turn changes the directional flow through the control valve. The valve will open and close only when the plunger is compressed. It is available in $\frac{1}{8}$ and $\frac{1}{4}$-inch port sizes. **Savage Engineering Div., Lithibar Co.**, 345 W. 14th St., Holland, Mich.

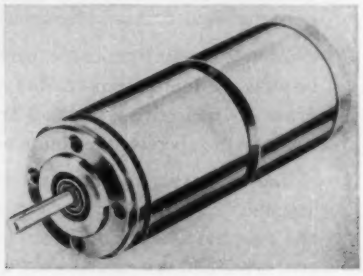
Circle 440 on Page 19



Variable Speed Drive

Drive features separate motor construction and horizontal assembly, is available in a selection of infinitely variable output speed ranges. Motor can be furnished in dripproof, totally-enclosed, or an explosionproof model. Output speeds range from 4660 to 1.2 rpm, speed variations from 2:1 to 10:1, with horsepower sizes from $\frac{1}{2}$ through 30 hp. **Sterling Electric Motors Inc.**, 5401 Telegraph Rd., Los Angeles 22, Calif.

Circle 441 on Page 19



Servomotor Generator

Servomotor-rate generator is designed for systems using 60 cycle power. The size 11 generator weighs 7.5 ounces, will operate continuously at stall at a unit temperature of

Cylinders need not be expendable

With Extras . . . At No Extra Cost

1. METAL PISTON ROD SCRAPER—protects rod packing, cylinder bore and rod surface by removing all foreign particles.
2. NEW "SUPER" CUSHION for air or METALLIC SELF-ALIGNING MASTER CUSHION for oil.
3. HARD CHROME PLATED CYLINDER BORES AND PISTON RODS for greater protection and reduced wear.
4. ONE PIECE PISTON assures better alignment, longer bearing and packing life.
5. FORGED SOLID STEEL HEADS throughout entire line.
6. PILOTED PACKING GLAND with extra long bearing for additional strength and support to piston rod.
7. NO TIE-RODS TO STRETCH—gives you 360° port rotation . . . less space used . . . full strength.
8. STREAMLINED DESIGN . . . operating pressures to 200 PSI, air; 1,000 PSI oil, non-shock.

Specify the

T-J Spacemaker

for longer, more efficient cylinder service

You too—can reduce replacement expenditures—lower maintenance costs with the T-J Spacemaker cylinder line. Designed and engineered for ruggedness, and accuracy of operation, the Spacemaker assures longer, uninterrupted operation.

The T-J Spacemaker eliminates tie-rods, gives greater strength, saves space . . . and reduces costs in all push-pull operations. Immediate delivery in a complete range of styles and capacities . . . air or oil. Write for Bulletin SM 155-4, today. The Tomkins-Johnson Company, Jackson, Michigan.

T-J TOMKINS-JOHNSON

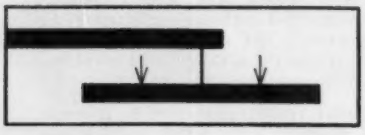
RIVETORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHORS

Circle 689 on Page 19

How did this team solve an age-old weighing problem?

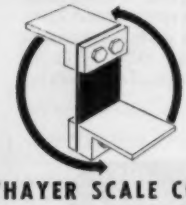
Since 5,000 B.C. men have been trying to devise a pivot balance that would be highly sensitive yet remain accurate. The breakthrough came in 1956 when the United States issued a patent for a "Thayer Flexure Plate" Leverage System. A team of engineers and businessmen, aware of industrys great cumulative loss of materials in weighing operations, had invented a revolutionary new scale.

Knife-edged pivots that progressively wear and change were replaced by Thayer Flexure Plates that move only .001", yet accurately reflect the minutest changes in weight. This *firmly joined* lever withstands shocks and vibrations indefinitely. Dirt and dust are no longer a problem. Thayer guarantees this leverage system accurate for the life of the scale.



How Can It Save You Money Year After Year?

Working in conjunction with straight electrical controls, it forms the most reliable, low maintenance system ever devised to control processing or materials handling *by weight*. Literature on its application to filling, batching and checkweighing operations is available on request.



THAYER SCALE

AUTOWEIGHTION SYSTEMS FOR FILLING, BATCHING AND CHECKWEIGHING

THAYER SCALE CORP. THAYER PARK, PEMBROKE, MASS.

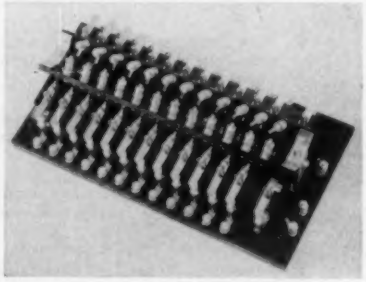
200 C. It can be driven by a 6.3 v filament supply, takes a power input of ⅜ w with a power factor of 0.99. An excitation input up to 26 v is available. The motor control phase is wound for 40 v, centertap; fixed phase for 57½ v. Windings can be altered to go as high as 115 v. No load speed is 3200 rpm; torque at stall, 0.65 oz-in. **Helipot Div., Beckman Instruments Inc.**, 2500 Fullerton Rd., Fullerton, Calif.

Circle 442 on Page 19

Dial Thermometer

Instrument has increased dial readability for ranges up to 1100 F, is available in either flush or wall mounted style. Ten scale ranges are applicable with Model TMF and the elements of the same scale range are interchangeable, allowing for field replacement of the element. **Partlow Corp.**, 524 Campion Rd., New Hartford, N. Y.

Circle 443 on Page 19



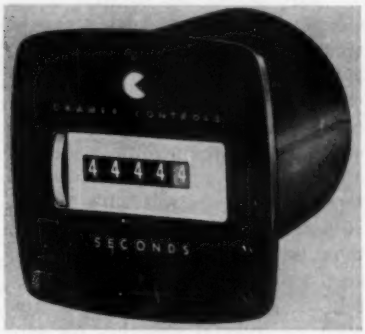
Mechanically Held Relay

Mechanically held ac relay is available with up to 24 poles. It is rated 25 amp per pole for noninductive loads on ac. This number of poles permits the units to be used as primary relay devices controlling

Circle 690 on Page 19

contactors and solenoid valves, or as branch circuit devices directly controlling electric ovens and furnaces. The relay can be furnished for separate 3-wire remote control. The 3-wire remote control system used requires a controlling device equivalent to a single pole double throw contact. One contact is used to close the switch and the other contact to open the switch. These contacts make but do not break any current. Control current is interrupted by contacts within the switch. The controlling device can be a momentary contact push-button station with two normally open momentary contacts, a 3-way toggle switch maintained or momentary contact, a single pole double throw contact on a time switch, or two single pole single throw relays. Unit is rated to 600 v ac. **Automatic Switch Co.**, Florham Park, N. J.

Circle 444 on Page 19



Time Meter

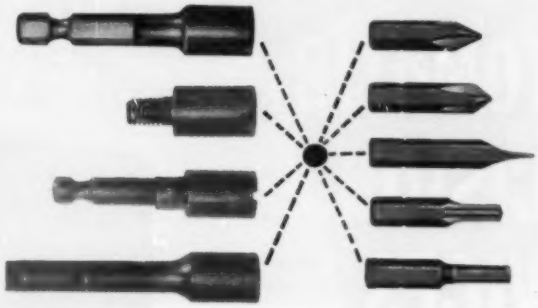
Time-totalizer (Model 632) can record elapsed time in industrial or laboratory operations Time ranges available are seconds or tenths of seconds, minutes, tenths or hundredths of minutes, hours, and tenths or hundredths of hours. High-torque instant start-stop motor drives a drum-type counter from the moment power is applied. External connections can be arranged to operate the meter during equipment running time, idle time, or any operational phase. Motors can be specified for 115 or 220 v ac, 60, 50, or 25 cycles; and in limited time ranges for 115 v, 400 cycle ac, or for any voltage between 6 and 32 v dc. **Cramer Controls Corp.**, Centerbrook, Conn.

Circle 445 on Page 19

APEX the authority on fastening

you'll know you're using APEX insert bits when your fastening costs go down!

The notches in an Apex insert bit are more than mere identification. This groove—and only one is really necessary—is precisely positioned to accept the retaining ring in Apex bit holders. This original, patented Apex development prevents the bit from dropping out of the holder during the driving operation—just one more reason why your fastening costs are lower when you use Apex tools.

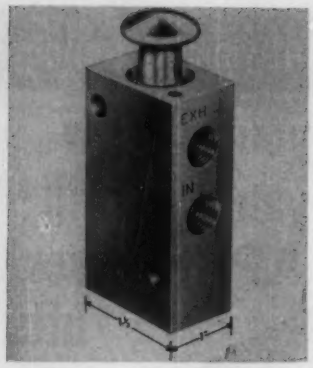


Apex bit holders, standard and magnetic, are available in shank types to fit all popular makes of air, electric and manual drivers. Each holder will accept a full range of insert bits to drive various types and sizes of screws. U.S. Patent No. 2,522,217; Canadian Patent No. 440,632. All part numbers original and copyrighted.

CATALOG 30-C Apex Screwdriving Tools, to drive Phillips, Frearson (Reed & Prince), Slotted, Clutch Head, Socket Head (Allen Type), Hex Head and special screws.

APEX FASTENING TOOLS
SCREWDRIVING • NUT RUNNING • SPECIAL

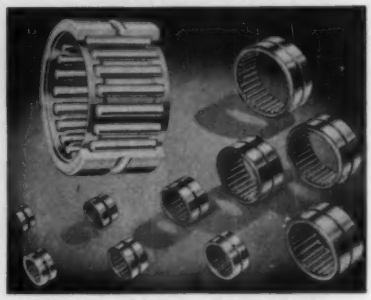
Circle 691 on Page 19



Subminiature Valve

Designed for limited mounting space, subminiature valve is suitable for controlling small cylinders, for operating diaphragms, or pilot cylinders. Valve is rated for 0 to 125 psi, for air, oil, water, or high vacuum service, is tapped for $\frac{1}{4}$ or $\frac{1}{8}$-inch pipe connections. The valve chambers are formed with aluminum spacers which support and position the O-ring seals. The valve plunger (constructed of stainless steel) is the only moving part besides the operating mechanism. Unit is available with six valve actions: Palm operated, lever operated, ball cam actuated, pilot operated—spring returned, double pilot operated, and pilot operated—bucking cylinder returned. **Hunt Valve Co.**, Salem, Ohio.

Circle 446 on Page 19



Roller Bearings

Line of channel-shaped outer ring roller bearings is available in sizes ranging from $\frac{3}{4}$ to 4-inch bore. They can be applied directly to hardened and ground shafts or used with inner rings. A cage bar depressed within the roller pitch circle separates roller guiding and roller retaining functions. Roller guidance takes place at the ends of the rollers and at the pitch line. Rollers are retained by the middle portion of the cage bar which is always out of contact with the rollers during operation. The rollers have controlled contour profiles; the ends are a few hundred-thousandths of an inch less in diameter than the middle. This design prevents stress concentration at the ends of the rollers and provides a uniform load distribution. **Torrington Co.**, Torrington, Conn.

Circle 447 on Page 19

Pneumatic-Electric Switch

Device combines a two level stage switching action to provide an electrical switch mechanism in a vapor-proof and explosion - proof switch housing mounted physically over a pneumatic splash - proof switch mechanism. Model J-1 S-1 VP can be set up so that either electric or pneumatic action can be secured as the first stage on rising level regardless of the physical positioning of each mechanism. Unit can use either air or gas as an operating pressure medium, is available with all styles of actuators—top-mounting controls with threaded or flanged connections; side-mounting controls with float and stem extending into a tank or vessel; and external float cage controls with an integral chamber for piping to a tank or vessel. **Magnetrol Inc.**, 2110 S. Marshall Blvd., Chicago 23, Ill.

Circle 448 on Page 19

AUTOMATIC DECISION DEVICES

precision GO..NO-GO voltage comparators

various models to choose from vacuum tube or transistorized

model 3T

APPLICATIONS:
Automatic Go... No-Go Testing
Automatic Decision Making
Automatic Checkout Circuits
Automatic Control
Automatic Voltage Calibration

MORE SENSITIVE & PRECISE THAN METER RELAYS

Comparative sensitivity—better than 1 millivolt
Repeatability of trip point—better than 50 microvolts
Output—relay contacts for external connections

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Additional Products:
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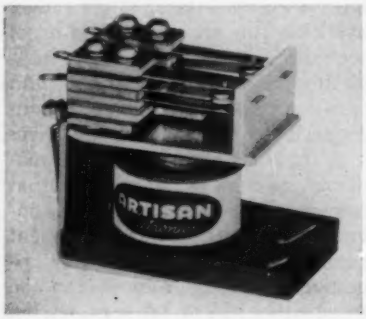
Circle 692 on Page 19

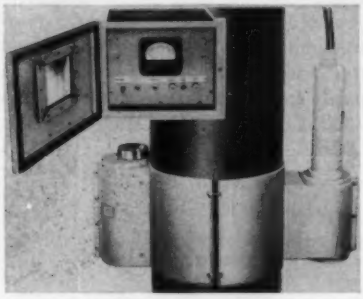


Relay

Unit, constructed to provide a large amount of contact wipe and

high contact pressure, features a nylon blade lifter. It is applicable on industrial control and electronic equipment. Model RH is available in voltages up to 230 v ac and 110 v dc. It can be supplied with contact arrangements up to 4 PDT with a choice of 5 amp or 10 amp contacts. **Artisan Electronics Corp.**, 171 Ridgedale Ave., Morristown, N. J.

Circle 449 on Page 19

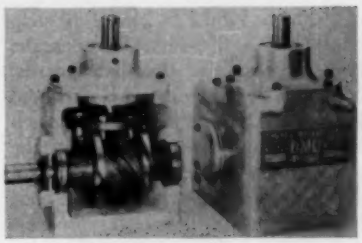


Density Measuring Unit

Density measuring unit uses gamma radiation to automatically and continuously measure fluid density, specific gravity, or per cent solids in liquids. It can be used on equipment such as evaporators, thickeners, dryers, and raw mills. Device provides an output signal that is suitable for operating any 0-20 mv recorder/controller. The power supply (inset, upper left) of this unit operates on 103-217 v ac, 60 cycle, 200 w.

The gage unit (Model LSG in the illustration) is designed for use on bare or insulated pipes which have a diameter from 4 to 14 inches. It has a full scale measurement range as narrow as 0.10 specific gravity units with a precision as narrow as ±0.002 sgu. In operation, the gage assembly is clamped to the pipe at a desired location. Gamma radiation energy from the radioactive source passes through the pipe and the material flowing inside. The amount of energy absorbed by the material is proportional to the density of the material. Radiation that is not absorbed is detected by a cell which changes radioactive energy directly into electrical energy. **Ohmart Corp.**, 2236 Bogen St., Cincinnati 22, Ohio.

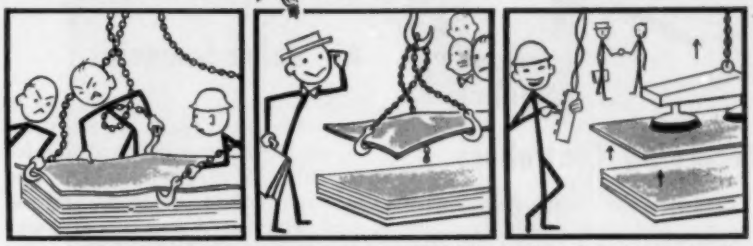
Circle 450 on Page 19



Indexing Drive

Unit is capable of speeds up to 1000 indexes per minute, with output torque ratings of 1100 lb-in. per minute. This speed is possible because of a modified trapezoid acceleration which provides jerk free start and stop of the motion and a minimum force on the cam followers. The drive assembly uses a hardened and ground tool steel cam with preloading of roller bearing followers. In the *Dwell* position, the preloaded followers provide zero backlash. Indexing accuracy is held to within 0.001-inch on a 12-inch circle. Drive is available with indexing periods of 270, 180, or 120

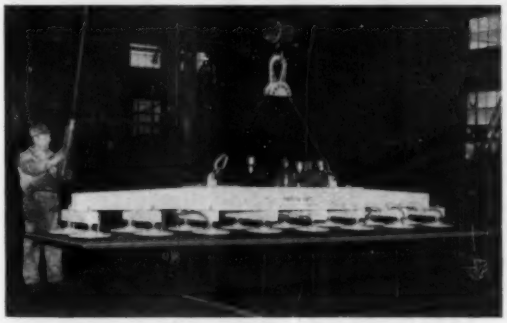
VAC-U-LIFT VAN Solves another Material Handling Problem!



1 A group of the hardworking boys were lifting steel plate—a real bottleneck and backbreaking job that hasn't changed for years . . . but then . . .

2 Along came VAC-U-LIFT VAN — Of course this problem was a natural since he had helped a lot of other industries with this same problem.

3 Back from the plant with a speedy quote . . . quick delivery of a unit, VAC-U-LIFT VAN has made a new group of friends.



VACUUM STEEL PLATE HANDLER

Prior to installation of the vacuum plate handler, the same operation required 3 men for operation of the crane and attaching chains. The Vac-U-Lift unit shown in photograph requires only one man for complete operation which means faster, safer and more economical steel plate handling. This unit lifts and conveys over 4½ tons of steel plate and is adaptable for use with overhead traveling crane, boom crane and stiff-leg crane.

Your problem may not be illustrated here, but if you do have a handling problem, Vac-U-Lift's experience and engineering know-how, through the expert use of vacuum, can help you. Vac-U-Lift systems are currently being used to control, position, and maneuver a multitude of materials weighing from 20 tons down to a few ounces.

All Vac-U-Lift units carry a full 3 month unconditional warranty.

VAC-U-LIFT

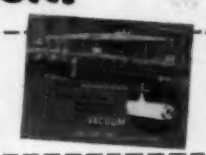
HAS THE SOLUTION!

Send Today For FREE Illustrated Brochure

This brochure shows some of the many VAC-U-LIFT systems now in use. It explains how VAC-U-LIFT works and how you can take advantage of VAC-U-LIFT'S 3-step analyzation service without cost or obligation, write

DEPT. VL-87, VAC-U-LIFT CO., Salem, Illinois

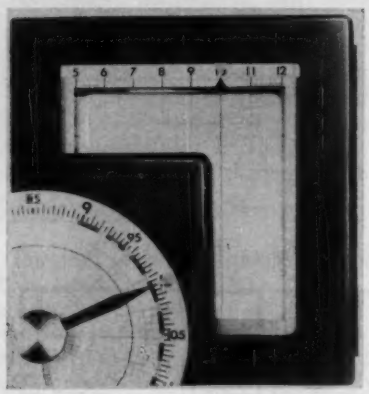
Division of the Siegler Corporation



Circle 693 on Page 19

degrees, with 3, 4, 6, 8, and 12 stops—left or right-hand cams. **Commercial Cam & Machine Co.**, 455 N. Artesian Ave., Chicago 12, Ill.

Circle 451 on Page 19



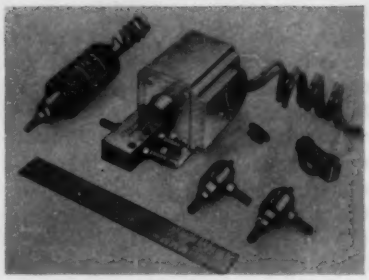
Recording Controllers

Designed for steam temperature control, recording controllers have an accuracy of better than ±0.3 per cent, with a sensitivity better than ±0.1 per cent within a range of 500 to 1200 F. Model S strip chart has a 6½-inch linear scale, is best suited for detailed records; Model R is recommended for bold indications. Curves are plotted along a straight-line radial scale, can be easily read. The control slidewires and adjustable alarm contacts for the units are mounted on a rigid shaft for permanent alignment. A safety feature is a factory-set high-alarm contact to lock out control and sound an alarm in the event of a severe disturbance, or a thermocouple or amplifier failure. **Leeds & Northrup Co.**, 4934 Stenton Ave., Philadelphia 44, Pa.

Circle 452 on Page 19

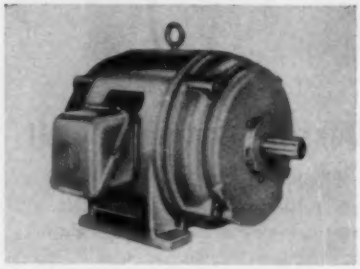
Air Valve Solenoids

Miniature air valve activating solenoids are available in two styles —one for dc operation and one for regular 115 v line operation. The dc type unit is designed for use with company's miniature 2-way and 3-way air valves. Operating pressure is up to 150 psi air. The 115 v unit can operate at 0.81 amp,



is also suitable for 2, 3, and 4-way valves. The solenoid coils in both types can be removed and easily replaced. Illustration shows the two solenoids, plus a manual pushbutton and cam follower head. **Clippard Instrument Laboratory Inc.**, 7390 Colerain Rd., Cincinnati 39, Ohio.

Circle 453 on Page 19



Dripproof Motor

Line of dripproof motors is available in frames 364U through 445U. Feature of the motor is the ventilating system. The circulating of ventilating air within the motor frame is controlled by a series of integral cast baffles. Cooling air moves in a clockwise spiral direction, through the space between the stator core and the motor frame. The spiral motion of ventilating air provides equal cooling for all portions of the stator core and winding, regardless of the direction of rotation. In a standard motor, ventilating air which enters at the shaft end of the motor, discharges on the conduit box side of the motor between the feet. Air entering on the free end discharges on the opening opposite the conduit box. In a motor with conduit box located opposite to the standard position, the direction of air flow is reversed with reference to drive shaft location. **Fairbanks, Morse & Co.**, 600 S. Michigan Ave., Chicago 5, Ill.

Circle 454 on Page 19

MOLINE

FOR GREATER PRODUCTION • EFFICIENCY • SAVINGS

Use rugged, reliable "Hole Hog" machine tools for such jobs as:

★ Multi-Spindle Boring ★ Single and Multi-Spindle Honing
★ Straight Line Multi-Drilling ★ Adjustable Spindle Drilling
★ Vertical and Way-Type Fixed Center Drilling, Boring and Tapping
★ Special Multiple Operation Machine Tools

Twenty-Station, Ten-Unit Transfer Machine for boring, counterboring, chamfering and valve clearance operations on V-8 automotive engine blocks. (Shown)

Over 58 years of MachineTool Engineering experience is at your service. Tell us your particular problem.

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REPRESENTATIVES IN PRINCIPAL CITIES

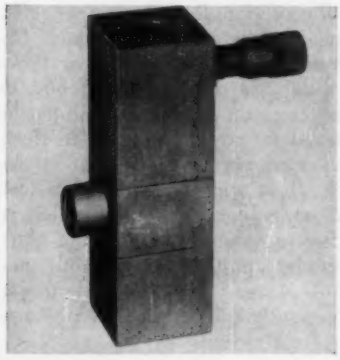
Circle 694 on Page 19

Transistorized Counter

Adaptable for numerical control of batching, sorting, mixing, winding, and packaging operations, preset unit can make up to 6 million counts per minute. Counter is constructed to withstand shock, vibra-

tion, explosive atmospheres, liquid splash, oil-mist, moisture, dust, and dirt. It can be mounted in any position and the connector can be located on the bottom, side, or rear of the counter. Model 300T is rated for 24 v ac or dc, will actuate any relay having a 12 to 18 v, 50 milliwatt to 3 w coil. **Erie-Pacific, Div., Erie Resistor Corp.**, 12932 S. Weber Way, Hawthorne, Calif.

Circle 455 on Page 19



Volume Regulator

Regulator can provide fully automatic regulations for control applications where a constant volume output of gas or air is necessary regardless of fluctuating pressure drop. A micrometer adjustment controls the capacity and provides the accuracy for the desired output. The output volume ranges from 5 to 180 scfh at pressure differentials from 1 to 25 psi. **George W. Dahl Co. Inc.**, 86 Tupelo St., Bristol, R. I.

Circle 456 on Page 19

PRACTICAL INSTRUMENTS FOR RELIABLE, LOW-COST MONITORING AND CONTROL OF ANY ELECTRICALLY MEASURABLE VARIABLE

THE A.P.I. METER-RELAY

Extremely sensitive and highly accurate, the versatile A.P.I. meter-relay offers low-cost monitoring and control for an amazing diversity of applications. It will operate on very small microampere or millivolt signals, can be used directly with such sensing elements as strain gages, thermocouples, photocells, differential transformers. In fact, you can use it with any electrically measurable variable.

Wherever you use it, you will get reliable performance. A unique locking-coil design assures positive contact pressure on every operation — even after as many as 10,000,000 make-break cycles. By greatly increasing the torque developed in the D'Arsonval movement, the locking coil drives the indicator and adjustable set-point contacts together and holds them firmly. An inherent wiping action keeps the contacts cleanly conductive, and a spring-loaded contact arm provides forceful, decisive break-contact upon reset.

Available in a wide variety of standard and ruggedized models, A.P.I. meter-relays are dependably doing thousands of jobs for industry, from quality-control checking to radiation-level control. Quite possibly they can serve you, too. For complete information, send for Catalog 4E.

api **ASSEMBLY PRODUCTS, INC.**
Chesterland 27, Ohio

S.A. 1092

Circle 695 on Page 19

SANDVIK
Steel Belt
CONVEYORS
have SPECIAL ABILITY
for automated
handling

Solid, flat band of cold rolled carbon steel—

RESISTS OIL, HEAT AND ABRASION

SIMPLIFIES LIVE BACKLOGGING AND AUTOMATIC DISCHARGE

EASILY FITTED WITH SIMPLE GUIDE AND DISCHARGE DEVICES

Contact your nearest Sandvik office

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Steel Belt Conveyor Department

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Fair Lawn, New Jersey
SWarthmore 7-6200
Cleveland • Chicago
Detroit • Los Angeles

IN CANADA: Sandvik Canadian Ltd., P. O. Dr 1335, Sta. O., Montreal 9, P. Q.

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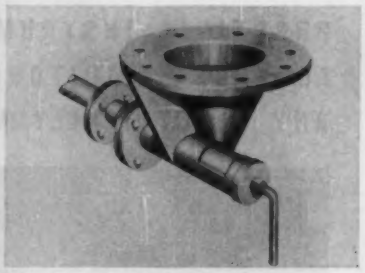

Material Intake Valve

Intake valve can be used with all types of high vacuum pneumatic systems used in the removal or transport of dry, free flowing, powdery, or granular materials from hoppers, bins, and dust collectors. The valve can be used on 2-inch through 6-inch pipe lines. It is equipped with 8-inch flanged connections for installation on any bin, hopper, or collector. The rate of material intake can be adjusted as long as the air is flowing. A separate air inlet prevents connected equipment from exposure to full suction of the vacuum system. **Air Appliance Div., U. S. Hoffman Machinery Corp.**, Dept. EM, 103 Fourth Ave., New York 3, N. Y.

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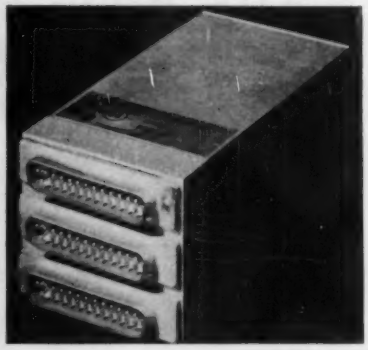

Sampling Switch

Multipole, sampling switch is suitable for high speed scanning of high and low level analog voltages and currents. The mechanical commutators are mounted in modularized miniaturized packages which interlock to give a high degree of mechanical strength to the total assembly. The interlocking modules allow from 24 to 90 contacts in one to six poles to be assembled in a frame. Multiple-contact wipers are mounted on the output shaft which, in turn, is mounted in precision ball bearings. The output shaft connects to the driver through gears. Illustration shows a 3-pole, thirty-channel unit. Drive is by 400 cycle or regulated dc rotary devices. **Fifth Dimension Inc.**, Princeton Research Park, North Ewing St., Princeton, N. J.

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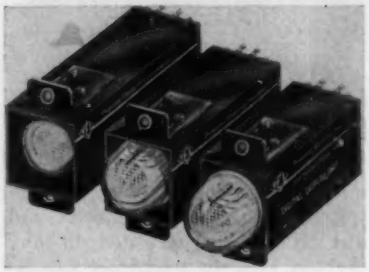

Digital Readouts

Self-contained, readout units can be driven directly from low level transistor signals. Each unit consists of standard Nixie tubes and up to ten transistor drive circuits. The signals required are +4 v for the *On* condition and 0 v for the *Off* condition. Both signals are referenced to the common terminal. The signal can be shifted up or down by the use of an external bias on the common terminal. Unit is designed for panel mounting in flush, extended, or semiextended styles. The flush and semiextended mounted units can include a polarized filter to reduce reflection and glare. Standard unit is rated for 180 v and 2 to 4 ma. **Transistor Electronics Corp.**, 3357 Republic Ave., Minneapolis 26, Minn.

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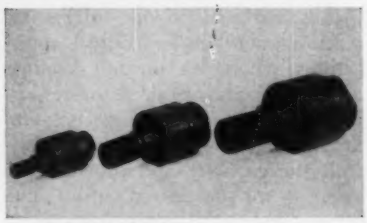

Rod End Coupler

Designed for air and hydraulic cylinders, device eliminates need for

precision axial alignment between the cylinder and machine. Use of rod end couplers allows greater machinery tolerances; smooth operation, free of binding; and it compensates for deflection in machinery due to movement of weights. The self-aligning units are constructed to meet the requirements of cylinders with either shouldered external thread or internal thread. The coupler is available for 5/8, 1, 1 3/8, 1 3/4, and 2-inch diameter rods. **Hydro-Line Mfg. Co.**, 5600 Pike Rd., Rockford, Ill.

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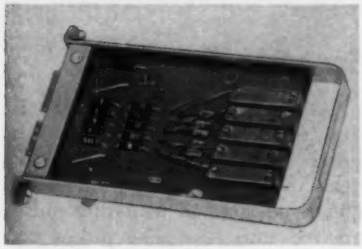


Square Root Circuit

Applicable in control and instrument systems for extracting square roots, or logarithms, device is rated for input voltages from 0 to 100 v dc. Frequency response extends from dc to 30 kc (3 db point). When used in the correct feedback circuit of dc amplifiers, they perform the inverse function so as to square or take the antilog of the input voltage. The frequency response extends from dc to 30 kc; input impedance is greater than 100 k. The load impedance should be one megohm or greater. A bias voltage of 12 v dc with current drain of less than 10 ma is required. Trimming potentiometers provide accuracies of ±1 per cent or better of output over an input voltage range of 1 to 100 v. **Plug-In Instruments Inc.**, 1416 Lebanon Rd., Nashville 10, Tenn.

Circle 461 on Page 19

Pneumatic Load Cell

Unit can weigh the contents of bins, tanks, truck tanks, conveyor

Announcing . . .

New Production Capacity

To Serve You Better

Large Generated Gears

SPUR—HERRINGBONE—HELICAL

for a wide range of industrial applications

Gears which must operate smoothly and without vibration at higher speeds and under greater loads must correspondingly be more accurate in tooth profile and spacing.

H & S Generated Gears provide these results.

To meet increasing customer demands, Horsburgh & Scott has broadened its manufacturing capacity and tooled to produce *large* Generated Gears up to 125" diameter.

Offering the same high quality standards which characterize the complete H & S Gear line, production capacities for large Spur, Helical and Hobbed-Herringbone Gears are now available in the following dimensions:

Up to 80" outside diameter at 1 DP
Up to 90" outside diameter at 1¼ DP
Up to 100" outside diameter at 1½ DP
Up to 125" outside diameter at 2 DP

Face widths up to 42", depending on helix angle.

Take advantage of this new capacity, and our long experience as specialists in this field. Send your specifications, drawings or plans — or tell us about your power transmission problem. Our technical staff will promptly consider your requirements and render recommendations and quotations.

THE HORSBURGH & SCOTT CO.

GEARS AND SPEED REDUCERS

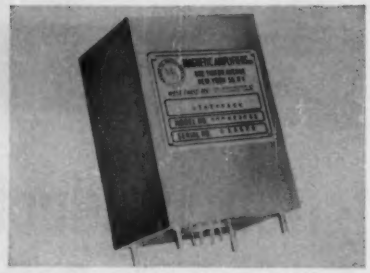
5112 Hamilton Avenue • Cleveland 14, Ohio

Circle 697 on Page 19

loads, or anything that can be weighed on platform scales. It can handle loads ranging from 0-300 lb to 0-200,000 lb. Accuracy is better than 1/10 of 1 per cent. In operation, a small load cell is placed under each leg of the tank, bin, or unit to be weighed. An adjustment of the height-adjusting screw of each load cell will raise the item, so that it is supported on a column of air in the load cell. By adjusting a screw, unevenness in floor levels can be corrected up to ¼-inch differential.

The linear pneumatic pressure is automatically controlled in each load cell, so that a pneumatic signal is directly proportional to the load. Any changes in the load are read on a remote indicating meter. Feature of the unit is a constant height device which remains the same regardless of an increase or decrease in the load. When there is an increase in the load, there is a corresponding and automatic increase in the air pressure to balance the load without changing the height. **Weber Air-Weigh Co.**, 13845 Elmira, Detroit 27, Mich.

Circle 462 on Page 19



Static Magnetic Switch

Device controls the power used to operate industrial machines, opens and closes circuits without utilizing any moving parts, and transmits, in proper sequence, the electrical signals required to motivate different manufacturing processes. It is applicable for various functions involved in the processing of chemicals and foods and for regulating steel rolling mills. Designated Stat-Pack, the unit is basically a high performance magnetic amplifier comprised of toroidally wound magnetic cores and silicon rectifiers. The static magnetic switch has two control windings—a bias winding and a feedback winding. Application of 1 ma of power from a 5 v control source permits switching of loads up to 20 w. **Magnetic Amplifiers Inc.**, 632 Tinton Ave., New York 55, N. Y.

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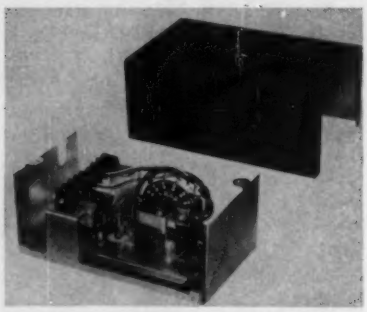

Sequence Controller

Instrument is capable of switching from two to twelve circuits in a predetermined sequence. It will repeat the same predetermined sequence as long as actuating pulses are fed into it. The pulses can come from a limit switch, foot switch, or photoelectric control relay. Switch contacts are primarily pilot duty, 3 amps at 115 v ac. Model SC-500 takes one step in the switching sequence for each energizing pulse fed in, but can be supplied to take two or more steps depending on individual requirements. **Warco Industries Inc.**, 6625 Delmar Blvd., St. Louis 3, Mo.

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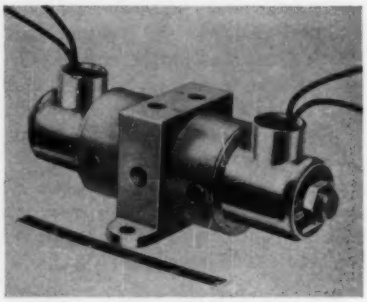

Solenoid Valve

Corrosion-proof, 4-way solenoid valve is furnished in ⅛ orifice (0-300 psi) to 3/16 orifice (0-90 psi) sizes. It has only two internal moving parts and features protected solenoid coils which are completely

SPECIFIC for Braking • Actuation • Control

WAGNER SYSTEMS applied by Experienced Application Engineers COMPLETE . . . CONVENIENTLY PACKED

Don't just guess about the parts you need . . . Look to Wagner for numerous air and hydraulic systems to supply the muscle power for: FAIL-SAFE emergency braking . . . HIGH CONTROLLED force actuations . . . REMOTE CONTROLLED system actuation. Your Wagner Systems Engineer is backed by many years of experience in braking and control system design. Call him today.

WI59-3

WAGNER ELECTRIC Corporation

6400 Plymouth Ave.
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sealed from air, oil, gas, and water. The interchangeable coils are for continuous or intermittent duty, ac or dc, will not overheat on continuous duty. The one-piece valve plungers can be replaced without disturbing any piping. Valve is available with adjustable flow control and manual over-ride. **Airmatic Valve Inc.**, 7317 Associate Ave., Cleveland 9, Ohio.

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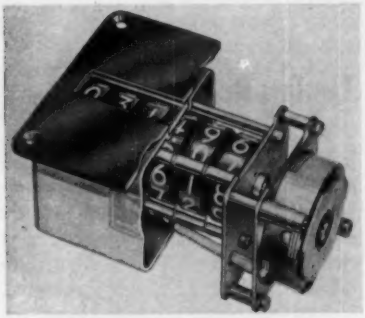


Pulse Counter

Low torque pulse counter (Model 2010) features a planetary gear drive which transfers numbers by activating a nylon cam and roller compensating device. This action always keeps the planetary gears in mesh, eliminating the possibility of skipping or missing a count. The counting drums, activated by a stepping motor, can be turned up to 40 counts per second. A standard counter is furnished with six drums, but it is also available in 2, 3, 4, and 5 drum types. **Haydon Instrument Co.**, Waterbury 20, Conn.

Circle 466 on Page 19

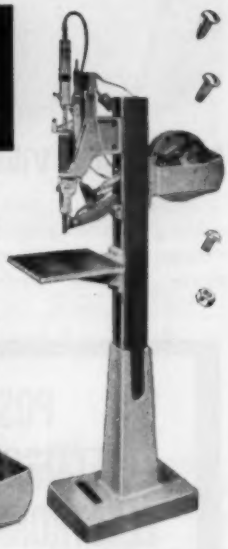
Program Timer

Timing device is adaptable for industrial process cycles where frequent changes have to be made. The time base consists of as many unit interval timers as is required by a program. Up to seven is standard for Model PB-3. Accuracy of timing in any given step can be held to within ¼ to ½ per cent of the actual interval. The timers in the base are plug-in units that can be replaced. With plugs inserted in appropriate jacks, the plugboard establishes the sequence of operation of the functions in relation to

the time base. Each single plug establishes a circuit. Vertical columns of jacks on the plugboard panel are connected to a common vertical bus bar fed by a related unit timer in the time base. Horizontal rows of jacks in the plugboard panel are connected to a common horizontal bus-bar, each of which commands a related power handling relay which serves either an external function or performs certain internal control duties. Unit will automatically reset itself when

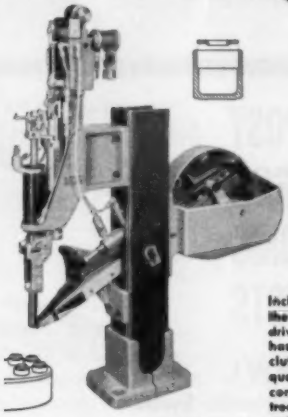
DIXON AUTOMATIC ASSEMBLY EQUIPMENT

For fast, accurate assembly of small parts, DIXON has developed two types of equipment: *Auto-Positioners* for automatic assembly work and *Auto-Torque Drivers* for automatic placing and the driving of screws and nuts. Many combinations of standard machines and components are available.



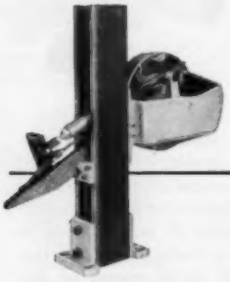
AUTO-POSITIONER

This small-parts assembly machine is available as a completely automatic station (at right) for use at a dial or straight transfer table, or it can be furnished as a self-contained machine with work table and foot treadle to initiate the cycle. Has positive-acting piece-parts feeder and sensing mechanism to stop the machine if part is missing or improperly placed. Easy to install and tool.



AUTO-TORQUE DRIVER

Including all major features of the DIXON Auto-Positioner, this driver for screws and nuts also has a compact air motor and a clutch that provides precise torque control. Furnished as a self-contained machine with foot-treadle control (above) or as an automatic station for use at dial or straight transfer table.



PIECE-PARTS FEEDER

Operated by an air cylinder which actuates the feeder drum and shuttle-type escapement, this feeder delivers parts to assembly machines or other equipment. The straight track and positive-acting escapement permit low-angle mounting and provide efficient parts control.

PARTS ESCAPEMENT

Releases parts singly or in multiples. Simple, efficient, operates at speeds up to 200 per minute. Models for air, solenoid or mechanical operation.

INTERMITTENT DRIVE

A compact clutch-brake unit, designed for accurate start-stop cycling of indexing mechanisms for assembly or other work. Wide range of speeds and torques.

Descriptive Bulletins will be sent on request.

DIXON **DIXON AUTOMATIC TOOL, INC.**

2312 - 23rd Avenue • Rockford, Illinois

EQUIPMENT FOR AUTOMATIC PARTS HANDLING AND ASSEMBLY

Circle 699 on Page 19

all installed timers complete their preadjusted excursion. When a setup for a program uses fewer than the installed number of timers, unused timers can be set to zero and reset will occur with a slight delay due to mechanical backlash. **Seely Instrument Co. Inc.**, 377 Fourth St., Niagara Falls, N. Y.

Circle 467 on Page 19

Dual Motor Vibrator

Applicable to prevent sticking, arching, or bridging and the continuous flow of bulk materials; dual motor vibrator produces straight line vibration in any direction. Model RC-31 has four weights, two on each motor, operates on a rotating eccentric weight principle. Adjustable eccentrics permit the force of vibration to be varied without changing weights. Variable impact range is from 640 to 2200 lb. Input is 1000 watts, 220 v, 3 phase, 60 cycle. **Cleveland Vibrator Co.**, 2828 Clinton, Cleveland, Ohio.

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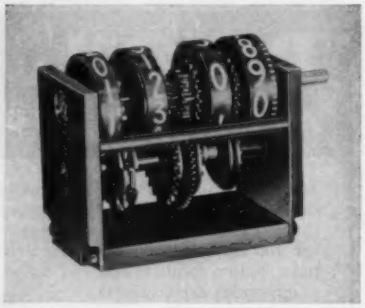
Counter Clock

Suitable for elapsed time readout applications, counter type clock provides 24-hour indications in minutes and hours. Model X-950 provides continuous and reversible operation from 00 00 to 23 59. The *minutes* drum is graduated in increments of 2/10 of a minute for fine readings. Normal operating speed is 1/10 rpm at the input shaft, but it can operate at speeds to 300 rpm for zeroing purposes. Counter is designed for use in temperature ranges from −30 C, where input torque is 0.75 in.-oz to 71 C. **Bowmar Instrument Corp.**, 8000 Bluffton Rd., Fort Wayne, Ind.



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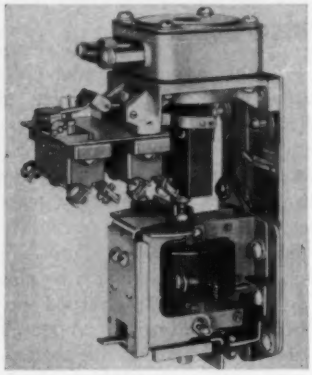
Timing Relay

Adjustable-range pneumatic timing relay has two normally open and two normally closed timed contacts. Two spdt snap switches are used for the timing contacts, and each can be separately adjusted to provide a definite timing sequence. Up to two instantaneous spdt interlocks can be furnished. The timing range is adjustable from 0.2 second to 3 minutes, with a repeat accuracy of ±10 per cent. Relay is available for either ac or dc operation. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis.

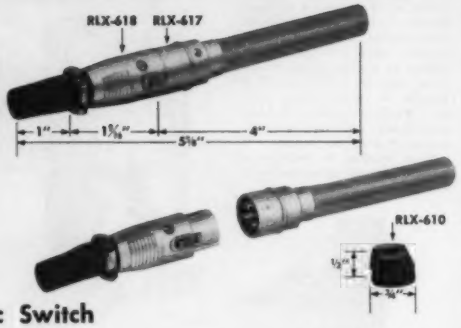


Circle 470 on Page 19

Solenoid Air Valve

Suitable for low pressure air systems to 150 psi, solenoid valve can be actuated by hand when needed, whether the coil is energized or de-energized. The hand actuation feature is handy for checking operational failures in a system without halting production. On jobs where powders, or granular substances are handled, the manual override en-

POST DECITRON ELECTRONIC PRODUCTS



NEW!
MH-2-P Magnetic Switch

A new and improved sensing device . . . neatly contained in an epoxy resin shell. The MH-2-P is ideal for industrial applications and is easier to mount in areas of limited access. A quick disconnect Cannon connector eliminates elbow type construction.

The new epoxy resin housing results in less magnetic flux and increased sensitivity. As a consequence, smaller magnets can be used and manufacturer reports a minimum magnetic field transient time of only 8 milliseconds is needed to activate the switch. Operating life is in excess of one billion operations.

Write For Bulletin MH-2-P

Decitron

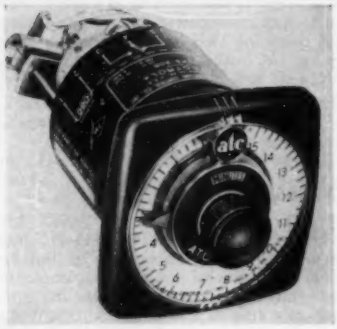
ELECTRONIC PRODUCTS DIVISION

Post Machinery Co. | 175 Eliot St., Beverly, Mass.

Circle 700 on Page 19

ables the operator to take care of hopper doors and free a sticking batch without interrupting the electrical cycle. **Barksdale Valves**, 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 471 on Page 19

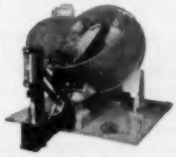


Reset Timer

Miniature, dc reset timer can automatically control industrial and machine process functions within variable timed intervals or sequences with a repeat accuracy of ¼ of one per cent. It will reset full scale length in less than 1/10 of a second, or stop on power failure or power interruption. Seven basic circuit arrangements provide an infinite number of combinations for control. Features of the unit (designated Series 305) include self-cleaning heavy duty silver contacts and a wiring schematic printed on the cover to eliminate errors in circuit identification. For repeat cycle operation, two or more timers can be combined, with each timer adjustable to a desired timing interval, either for reset or non-reset on power failure. Timer is rated for 6, 12, 24, 28, 32, 48, 125, or 250 v dc. **Automatic Timing & Controls Inc.**, King of Prussia, Pa.

Circle 472 on Page 19

VIBRATORY FEEDER for light, fragile or highly finished parts.



ROTARY FEEDER for high production feeding.

ROTARY HIGH SHELL FEEDER for maximum holding capacity.

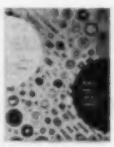
Shuffle and deal parts for automatic assembly with

DPS selective feeders

It takes fast, automatic feeding to satisfy the appetites of today's automatic assembly machines. And nowhere can you duplicate the range of equipment, the specialized experience in selective feeders offered by Detroit Power Screwdriver Company.

The most complete line in industry, DPS parts feeders include rotary, vibratory and elevator types. They handle any product from the tiniest of screws to assembly components the size of your fist . . . range in holding area from eighty cubic inches to 20 cubic feet.

DPS will welcome an invitation to analyze your assembly operations. If lagging production can be traced to inefficient feeding, the problem is as good as answered. Write for catalog on selective feeders.



DETROIT POWER SCREWDRIVER COMPANY 18.038

2811 W. Fort St. • Detroit 16, Michigan

A Subsidiary of Link-Belt Company

Circle 701 on Page 19

AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 19.

Metal Rolling & Processing

General Electric Co., One River Rd., Schenectady 5, N. Y.—28 *page handbook*—Bulletin GED-3893 entitled, "A Guidebook to Automation Through Modernization for the Metal Rolling & Processing Industry" discusses the concept of progressive automation. The tools of automation are described and it is related how those interested in rolling and processing metal should plan for automation. A detailed breakdown is given of automation potential in reversing hot mills, hot strip mills, processing lines, and specialized processes.

Circle 473 on Page 19

Linear Differential Transformer

Minatron Corp., 39 *Cliveden St., Belle Mead, N. J.*—8 *page bulletin*—Data are given in Bulletin 1201-A on control systems using linear differential transformers as ac transducers with ac or dc outputs. Points discussed include mountings, shielding, linearity, and excitation. Diagrams of simple circuits are included.

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Automatic Weighing Systems

Weighing & Control Components Inc., 632 E. County Line Rd., Hatboro, Pa.—24 *page catalog*—The automatic measurement and control of bulk materials through unitized weighing systems of pre-engineered components is the subject of Catalog 14. The components described in the system include weighing structures, electric and pneumatic weight transmitters, and readout devices such as indicators, recorders, totalizers, and digitizers. Schematic diagrams show the various applications.

Circle 475 on Page 19

Remote Control System

Femco Inc., Irwin, Pa.—2 *page pamphlet*—Subject of Bulletin 5904 is a wired system for gas distribution lines which telemeters levels, flows and pressures, and monitors and controls valves, pressure regulators, and compressors between the operations center and other points in the distribution system. The monitoring and control system is based on a circuit scanner, which is a synchronous commutator using hermetically sealed reed switches instead of sliding contacts.

Circle 476 on Page 19

Leasing Equipment

U. S. Leasing Corp., 130 *Montgomery St., San Francisco 4, Calif.*—12 *page booklet*—The importance and procedures of leasing machinery and equipment are explained. One of the subjects discussed is how profits are earned through the use, not the ownership of assets. Notes are also given on how to enter into a lease program.

Circle 477 on Page 19

Alarm Systems

Panalarm Div., Panellit Inc., 7401 *N. Hamlin Ave., Skokie, Ill.*—52 *page catalog*—Twelve different annunciator systems, described in Catalog 100C, continuously monitor the operating condition of an industrial system and indicate any off-normal condition which occurs in the system. Suggestions are given for selecting the proper annunciator for a specific operation. Illustrations show the various styles of cabinets—dimensional drawings of the cabinets are also included.

Circle 478 on Page 19

Indexing Machine Chassis

Swanson-Erie Corp., 814 *E. Eighth St., Erie, Pa.*—8 *page bulletin*—A straight line indexing machine chassis which can accommodate a wide variety of processing and assembling operations is described. Features such as indexing and carrier accuracy and pin clutch and shear pin arrangement are explained, aided by sketches. Also included are dimensional drawings and schematic diagrams of accessories.

Circle 479 on Page 19

Speed Reducers

Link-Belt Co., Dept. PR, Prudential Plaza, Chicago 1, Ill.—20 *page booklet*—In-line helical gear speed reducers in double, triple, and quadruple reduction are described in Book 2751. Notes are given on how to select the proper speed reducer and tables show load classes, service factors, horsepower and torque ratings, and overhung load for high and low speed shafts. Mounting arrangements are also included and photos illustrate the construction features.

Circle 480 on Page 19

Process Instrumentation

Industrial Nucleonics Corp., 650 *Ackerman Rd., Columbus* 14, *Ohio*—12 *page booklet*—Data are contained in Bulletin PI-959 on process industry measurement and control equipment. Included are units such as continuous level measurement systems, tank or bin level detector controller, continuous density measuring systems, container fill control systems, container inspection-rejection system, and pipewall thickness gages. Schematic sketches show typical methods of application and principles of operation.

Circle 481 on Page 19

Test Instruments

Minneapolis-Honeywell Regulator Co., Station M-321, Wayne & Windrim Avenues, Philadelphia 44, *Pa.*—48 *page catalog*—Data are contained in Catalog G-10 on instruments for measurement, recording, and testing. The instruments include dc amplifiers, millivoltmeters, nuclear amplifiers, potentiometers, magnetic tape recorders, null indicators, and temperature recorders. Illustrations and specifications of the various units are included.

Circle 482 on Page 19

Distillation Equipment

Rochester Div., Consolidated Electrodynamics Corp., 1775 *Mt. Read Blvd., Rochester* 3, *N. Y.*—16 *page booklet*—High-vacuum distillation equipment, which can produce material at rates up to 2000 lb per hour, is described in Bulletin 3-1. Data are given on different types of stills along with a schematic flow diagram of a centrifugal still. Suggestions are also included for selecting a still.

Circle 483 on Page 19

Bulk Handling Pumps

Blackmer Pump Co., Grand Rapids 9, Mich. — 6 page pamphlet — Rotary bulk handling pumps in sizes from 1¼ through 6 inches are covered in Bulletin 100. Application data and characteristics are given and photos show the different styles. Also included are condensed pump selection charts and pump selection codes.

Circle 484 on Page 19

Pushbutton Switches

Electrosnap Corp., 4218 W. Lake St., Chicago 24, Ill.—6-page pamphlet—Line of pushbutton panel switches for computers, office machinery, and machine tool control is described in Bulletin 55. Attention is given to two new models—a triple pole version of the switch and a solenoid-held model for sequencing control and interlock circuits. Dimensional drawings and mounting methods are included, along with ordering instructions.

Circle 485 on Page 19

Numerically Controlled Machine

Pratt & Whitney Co. Inc., Charter Oak Blvd., West Hartford 1, Conn.—28 page handbook—Machine described in Bulletin 624, designated Numeric-Keller, is designed and equipped for continuous, automatic contour milling under the direction of a tape-reading numerical control system. The steps in preparing the tape are outlined, as are the steps for processing the tape. A schematic drawing of the control system is given; pictorial reports of various case histories are also included.

Circle 486 on Page 19

Ball Bearings

Hoover Ball & Bearing Co., 5400 S. State Rd., Ann Arbor, Mich.—12 page booklet—Deep-groove ball bearings are covered in Bulletin 110. Construction materials are noted and data are given on different styles, such as open, single contact seal, double contact seal, contact seal and shield, felt seal and shield, single shield, and snap ring. Charts list load ratings and bearing dimensions.

Circle 487 on Page 19

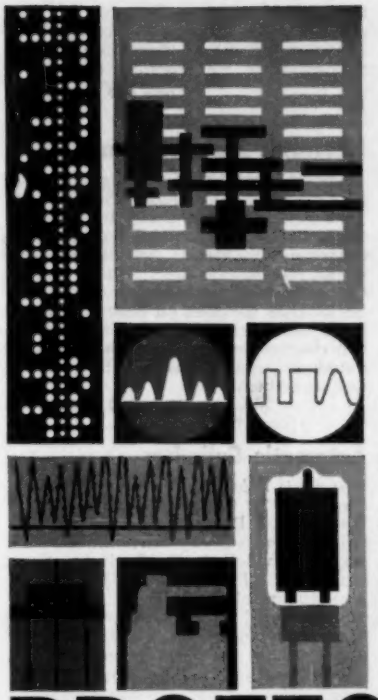
Photoelectric Systems

Photomation Inc., 96 S. Washington Ave., Bergenfield, N. J.—16 page booklet—Miniature photoelectric cells for counting, sorting, monitoring, assembling, and weighing applications are outlined in Bulletin 571. Types of units covered include: Direct, partial cut-off, and reflector. Schematic drawings show the different arrangements of the cells for various applications. Also covered are mounting arrangements and circuitry.

Circle 488 on Page 19

Speed-Draw Presses

Steelweld Machinery Div., Cleveland Crane & Engineering Co., Wickliffe, Ohio —8 page bulletin—Data are contained in Catalog 2029-A on single-point, single-action draw presses for deep-draw work and also for forming, blanking, piercing, trimming, and light embossing. Construc-



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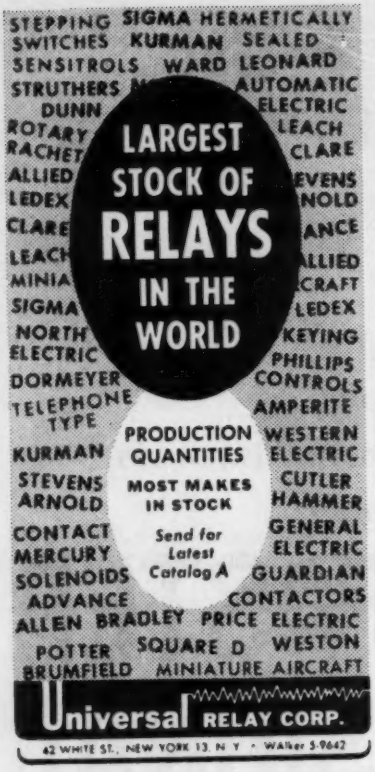

Circle 703 on Page 19

tion details and specifications for machines ranging in capacity from 200 to 1250 tons are given. Diagrams show the mechanism of the operating cycle.

Circle 489 on Page 19

Electronic Scale Instrumentation

Streeter-Amet Co., Grayslake, Ill. — 7 *page pamphlet* — Bulletin G340, entitled "Ametron Electronic Scale Instrumentation", discusses the combining of weighing components in various systems to detect, record, and indicate direct physical quantities, and perform automatic control functions. Data are given on basic instrumentation and accessories. An instrumentation chart shows different combinations of transducers, applications, basic instruments, and accessories.

Circle 490 on Page 19

Automatic Cylinders

Airmatic Valve Inc., 7317 Associate Ave., Cleveland 9, Ohio—24 *page catalog*—Details on a line of air, water, and oil cylinders and valve-cylinder combinations are given in Bulletin 91017. Included are small bore cylinders (from ⅜ to 2-inch bore size) rated for 0-200 psi; and valve-cylinder combinations rated for 0-300 psi. Charts list force rates, and schematic sketches show mounting dimensions.

Circle 491 on Page 19

Turbine Meters

Meter & Valve Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa. —12 *page booklet*—Turbine meters suitable for use in petroleum pipelines handling both crude and refined products are described in Bulletin OG-417. Basic principle of operation is explained and cutaway drawings show the features. Tables list accuracy and head loss curves. Also covered are accessories such as a temperature compensator, micro adjustment, and rotoshift register assembly.

Circle 492 on Page 19

Rectangular Power Connectors

Electronic Sales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.—20 *page booklet*—Miniature, rectangular power connectors for heavy duty applications in electronic equipment are described in Bulletin 1416-659. Data are given on four series in the group—one series (GA) is illustrated with 52 contacts and spring action center screwlock for fast engagement and disengagement.

Circle 493 on Page 19

Swing Joints

OPW-Jordan, 6013 Wiehe Rd., Cincinnati 13, Ohio—12 *page booklet*—Data are given in Catalog F-8 on 17 different styles of stainless steel swing joints, in 1¼ to 4-inch sizes. Specifications, chemical recommendations, and prices are listed. Sketches show the method for replacing an O-ring main seal and grease seal. Photos illustrate the replacement parts.

Circle 494 on Page 19

Power Control Units

Magnetic Amplifiers Inc., 632 Tinton Ave., New York 55, N. Y.—8 *page bulletin* —Five power control systems utilizing magnetic gating amplifiers driving silicon controlled rectifiers are described in Bulletin S-1075. The units, designed for proportional or switching control, are suitable for both 60 and 400 cps systems. Applications of the equipment for voltage/current regulation, ac servo motor control, and dc motor speed and position control are discussed. Illustrations show transfer characteristics and unit schematics.

Circle 495 on Page 19

Marking Equipment

Acromark Co., 492 Morrell St., Elizabeth, N. J.—12 *page booklet*—Line of marking and numbering machines is outlined. Included in the line are units such as steel and metal marking machines and tools, name-plate stamping machines, pneumatic and motor driven marking and numbering machines, hot stamping machines for plastics, and ink printing machines for marking metal, plastic, paper, wood, and fibre. A complete price list is also available on request.

Circle 496 on Page 19

Control Panels

Permutit Co., Div., Pfaudler Permutit Inc., 50 W. 44th St., New York 36, N. Y. —12 *page booklet*—A pictorial outline of modern water conditioning and ion exchange systems control assemblies is given in Bulletin 4543. This includes panels and cubicles (both conventional and graphic type) containing centralized in-

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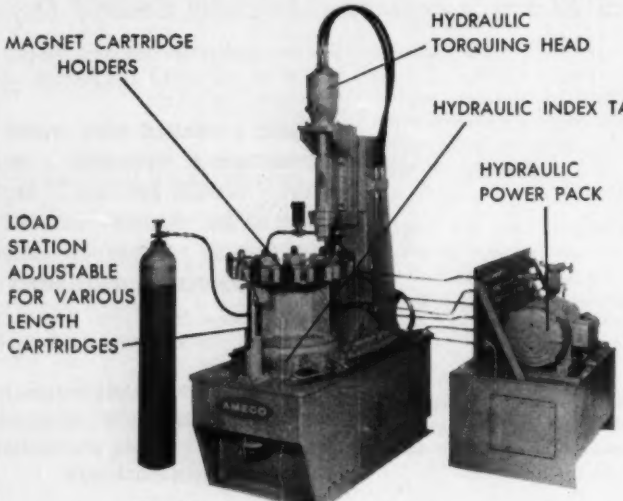

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Circle 704 on Page 19

strumentation for automatically controlling, recording, signalling, and monitoring system operations.

Circle 497 on Page 19

Annunciator Systems

Scam Instrument Corp., 1811 W. Irving Park Rd., Chicago 13, Ill.—36 page catalog—Annunciator systems for use in the continuous and automatic surveillance of pipelines, chemical and food processing, and power generation and distribution are described in Catalog 659. It is explained how annunciators function, and sketches show annunciator sequences. Operational and wiring diagrams are given, along with dimensional drawings and sequence charts.

Circle 498 on Page 19

Word Indicator Light

Master Specialties Co., 956 E. 108 St., Los Angeles 59, Calif.—12 page booklet—Word indicator light, designated Roto-Tellite, is the subject of Catalog 159C. The visible legend area of this unit will accommodate up to three rows of 0.125-inch high characters, fourteen per row. Schematic diagrams show the operation of dc diode test circuits and dimming circuits; other diagrams show positive input and negative input dc circuit arrangements. Also included are outline and mounting dimensions.

Circle 499 on Page 19

Panel Meters

Assembly Products Inc., Chesterland, Ohio—12 page booklet—Indicating panel meters and pyrometers for monitoring any electrically measurable variable are described in Bulletin 107. General specifications are given and details on the different styles are grouped according to case types. Also covered are accessories such as transformers, thermocouples, and shunts.

Circle 500 on Page 19

Rivet Setters

Chicago Rivet & Machine Co., 950 S. 25th Ave., Bellwood, Ill.—4 page pamphlet—Single and multiple rivet setters for the automatic production-fastening of fragile and uneven materials are outlined. The setters are air powered and air cushioned in operation. A chart lists the specifications for the various models.

Circle 501 on Page 19

Servomotors

Helipot Div., Beckman Instruments Inc., 2500 Fullerton Rd., Fullerton, Calif.—16 page booklet—Data are given on size 15 servomotors, servomotor rate generators, and inertia-damp and adjustable velocity-damp servomotors which have torque-to-inertia ratios. Dimensional and schematic drawings are included with graphs showing torque-speed curves.

Circle 502 on Page 19

Compressed Air Filter

Hankison Corp., College & Pike, Canonsburg, Pa.—4 page pamphlet—Two units which combine a condenser, separator, filter, and internal trap are described in Bulletin 4158. Construction and operation is explained, aided by a cutaway photo. Features such as a disposable filter cartridge and condensing section are noted.

Circle 503 on Page 19

Transformers

Acme Electric Corp., Cuba, N. Y.—6 page bulletin—Line of boost and buck transformers with wiring compartment connection taps which provide increasing line voltage or reducing line voltage is described in Catalog 5A3. A method of cascading transformers to obtain the necessary voltage correction required is explained, and graphs show a way of determining per cent of voltage correction required and a way of calculating correction of voltage.

Circle 504 on Page 19

Control Drives

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—6 page pamphlet—Control drives capable of producing torques from 50 to 2250 ft-lb and suitable for high temperature applications to 250 F are described in Bulletin P81-1. Operation of the positioning relay and self-contained diaphragm controller is explained, aided by schematic diagrams. External and mounting dimensions are also given.

Circle 505 on Page 19

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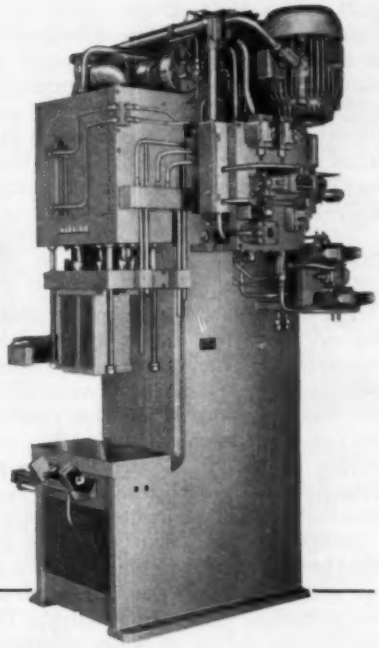

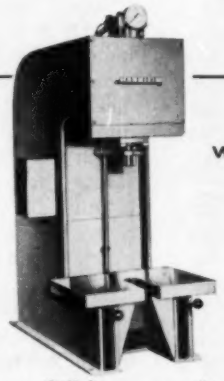

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Circle 705 on Page 19

AUTOMATION abstracts

DATA HANDLING SYSTEMS FOR PROCESS CONTROL

By GEOFFREY POST
Genesys Corp.
Los Angeles, Calif.

DATA HANDLING is a phrase that usually represents the broadest form of communication, manipulation, digestion, computation, and control of information. Information may be considered to be intelligence of value to a system. A well-designed system performs its functions with a minimum of information and with the simplest configuration inclusive of the general attributes named. A more detailed breakdown of these system attributes is shown in TABLE 1. Practical rules of thumb for the system attributes will be discussed in terms of a digital control computer for a refinery process, *Fig.* 1.

Communication

The most elaborate design attribute, and probably the most costly, is that of system communication. Information is normally expressed in many languages in data handling systems. The more languages, the more cost in input and output translation and the higher the complexity of the system. High system complexity, in turn, leads to inefficient operation and unreliability. Therefore, wherever possible, the need for language translation should be limited.

Several types of languages are involved in determining process behavior for the system of *Fig.* 1. For example, the language of a chromatograph used to determine composition is thermal conductivity. This is usually exhibited as a change in bridge voltage. Pressure may be represented by a pneumatic signal, temperature by a low-level dc voltage, and liquid level by a mechanical setting. Usual practice is to convert these languages by transducers into a simple, common language such as dc voltage. Transduction at this point is relatively inexpensive except possibly for thermocouple outputs which may require special amplifiers having low noise levels.

Having achieved dc voltage analog signals representative of process behavior, a second conversion, that of computer language, is needed. The simplest digital computer language is a serial binary pulse train. This implies that one component can handle the input digital language one pulse at a time. This approach, however, means slowing the handling rate so that each input variable is allowed individual entry to the computer. This is further complicated by the selection of variables which can also be time-shared or selected one at a time. Thus, a relay or stepping switch will look at one variable only while conversion is occurring.

The sampling rate is predetermined by controlled process accuracy and response characteristics. This rate must at least be twice the highest frequency rate in the system under control to be able to follow changes in this frequency, and at least five times that frequency rate to allow accuracy in control.

Languages in coded digital form are another problem to be faced in the communications end of the computer system. Special coded inputs are necessary for program control of the computer from an external console, plugboard, or other such unit. This is necessary in computer operation when the computer is extended in its sophistication of control, new variable limits are set in, or other programming requirements evolve as use of the computer system proceeds.

Table 1—Attributes of Data Handling Systems

Communication	Manipulation	Digestion	Computation	Control
Input translation	Selection	Memory	Arithmetic	Input-output actuators & controllers
Output translation	Sampling		Serial	
Internal language system	Collation		Parallel	
External language system			Dynamic	

Again, simplicity is achieved if the coding can be directly in the language of the computer; that is, a serial binary language. This is slow and in this programming sense may require speeding up. One of the simplest means for filling a serial binary group of information into a digital computer is the punched paper tape in which the digits are put in an octal code. Extensive savings in equipment can be made if this approach is utilized for reprogramming. Almost any other currently available translation equipment requires more complexity, more cost, and less reliability for reprogramming.

The digital to analog conversion problem again involves the system sampling rate in terms of the controlled variables. It has the same criteria in terms of returning information to the controller that has been required on the input analog-to-digital conversion; i.e., to give control signals to the controller in less time than a minimum change in the controlled variable can occur. This equipment can be time shared, so that it is very important that the variable is "touched" enough times to be sure that firm control has been established during a sampling cycle.

Language translation is difficult when one is drawing from pure binary to dc voltage. On most computers,

conversion from binary to dc voltage is accomplished through a current weighting type of system which requires a good deal of equipment for the translation, even if it is time shared equipment. A superior approach would be the utilization of non-binary weighted trains, which can be integrated to form a control signal by the simplest of analog devices or by the actuators themselves. This is employed by at least one process control digital computer available today.

There is another problem, which is sometimes not thought of as important in such a system, and that is internal communication of the computer itself. Many times, if the computer language is complicated, equipment can be simplified internal to the computer to save a great deal of hardware by utilizing a clever communication scheme. This is usually specified by a proper logical design. Usually, this design is a time-sharing scheme internal to the machine and utilizes one component to do many jobs by the process of slowing down the computation rate, or by substitution of memory for components.

With all these slowing down considerations, there must still be plenty of time in a process control system to come out with an adequate answer in time to make a proper decision in any of the controller loops.

Manipulation

Manipulation may be described as the process of picking out information in a system and placing it in a proper "bin" or channel for use elsewhere. This involves the process of variable selection, collation, and sampling. Sampling in this sense is not the same as the sampling rate discussed in *Communication*, but means monitoring a set of data passing through a computation phase for certain requirements (that is, does it or does it not exceed a certain point), and then using that data to change the nature of the computation.

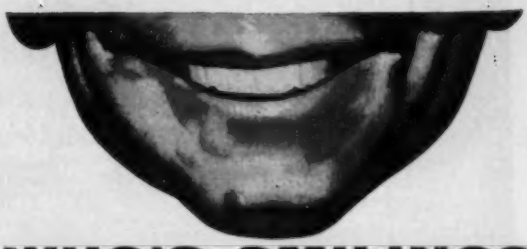
Collation means automatically taking the data that belong together in a group of formulas or computation equations and placing them in the right address points in the memory so that they can be applied, added, or put in their appropriate locations for further use. Selection means the ability to pick out any one or more of any pieces of data at any time for presentation in a display.

Manipulation occurs in the simplest form in the special purpose type of digital control computer since manipulation requirements have been determined and minimum equipment has been used. Complication and unreliability usually occur in this function with the more general purpose type of equipment because of the straining required to fit all of these different functions into integrated action.

Digestion

Data digestion usually occurs in the system memory. While this function is closely coupled to the computation phase of system operation, it has been set apart to point out that memory—whereby information may be dumped into a store for use when desired—is a useful function of itself.

Memory is the outstanding attribute of a digital computer that can be traded for hardware. Although at



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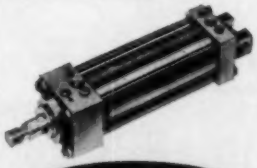

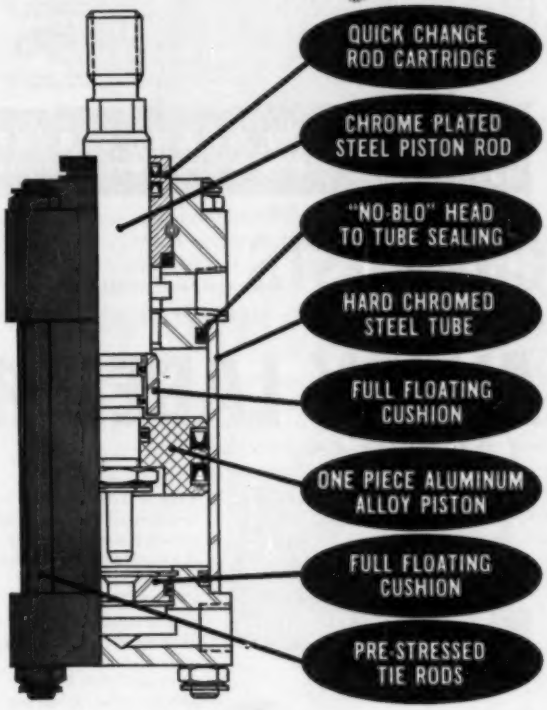
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Circle 708 on Page 19

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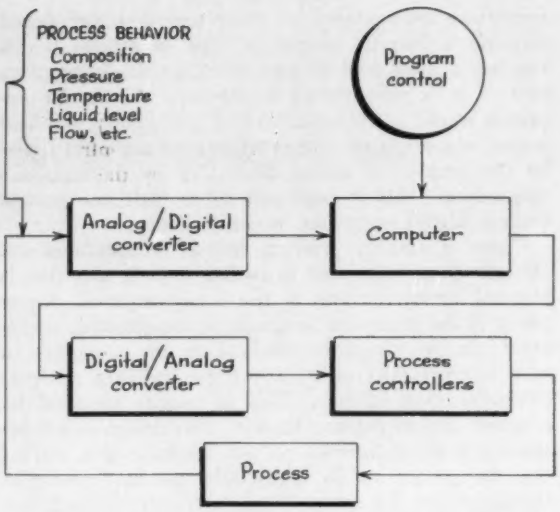

Fig. 1—Block diagram of refinery process control system illustrates data handling elements and flow path for control information.

the expense of speed, such a trade can greatly simplify the functions of manipulation and communication within a computer system. A large and efficiently mechanized memory also allows the carrying out of extensive, sophisticated computations. A minimum memory may have a capacity of the order of 180,000 bits of information.

Computation

Forms of computation on a digital control computer have several interesting breakdowns. The normal concept of the general purpose digital computer is that of an arithmetic machine which performs all types of computation by addition. In this mode of computation there is the facet of serial or parallel computation, or both, to consider. Serial computation means handling one bit or pulse at a time; parallel means handling more than one simultaneously. This brings up the qualification for speed of computation. If it is desired to perform everything by general purpose addition computers, in order to perform more sophisticated types of computation it is necessary to have many, many iterations or addition times to perform a useful computation. Therefore, the computer has to become a parallel type of machine, or a serial-parallel type of machine combination, to meet even the slow requirements of process control.

This difficulty may be overcome by the use of the dynamic store type of digital computer, sometimes known as an incremental computer or digital differential analyzer. In this form of computer, regular digital registers, normally used for arithmetic operations, are combined to perform a certain type of numerical integration. Two words in a digital differential analyzer may be the equivalent of 10 or 15 words in an arithmetic computer for an equal function. This type of operation is naturally compatible with control system operation which involves differential equations or dy-

namic control. It is especially suited to slow, nonlinear control systems.

Control

One of the main parameters to consider in the control of the process itself is speed of control, which is tied to the sampling speed. This is concerned with response and accuracy of the control parameters involved. High speed is usually of small concern in a process control system except in emergency start and stop procedures or special alarm procedures necessary in reaction controls.

Input-output control is an important facet of consideration for practical design in data handling systems. There are more than just language functions to be considered. Many times there is a need to perform data logging functions or special monitoring, and there will be schemes for checking the system operation on the output. Another important control function can be the way information is processed into output devices such as printers, plotters, or enunciator systems.

In these cases, an efficient means of performing this control is through an operator-controlled plugboard or pinboard unit so that an operator can establish true supervisory control and check whether it's the computer, the input-output equipment, or the system which is at fault under certain alarm conditions. He can also plot process trends and decide when these are going to give trouble or data log certain variables that may be desirable for operating qualities to be kept under surveillance.

Last, but not least, is the problem of actually controlling physical actuators and/or controller set points. In this case, the choice of reliability through a redundant controller or driving an actuator directly may be necessary. The former in most processes is the more desirable, even with the most reliable computer, because over-all control system flexibility is increased and there is essentially no increase in investment to have the added redundancy. Again, dc voltage seems the most efficient control language for set points and the cheapest to implement.

From a paper entitled "Practical Philosophical Considerations in Data Handling Systems" presented at the 14th Annual Instrument-Automation Conference sponsored by the Instrument Society of America, Chicago, Sept. 1959.

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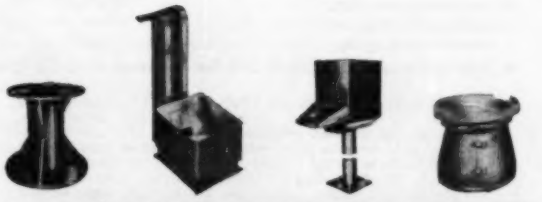

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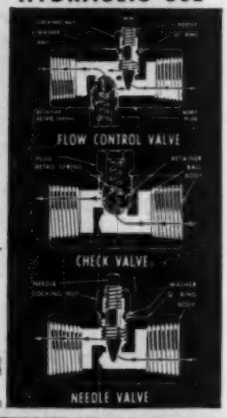
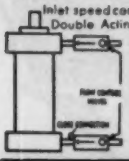
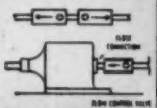


Inlet speed control for Double Acting Cylinder.



Single Acting Cylinder Speed Control.



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to subordinates. This is a serious mistake. Automation cuts across all departments of an organization, and should be dealt with accordingly. Research, marketing, engineering, manufacturing, production, warehousing, and accounting all enter into a good automation program. The person that co-ordinates such a combination of business activities must, by nature of the problem, be a member of top management.

Program Objectives

Management's job is to set the objectives, assign responsibilities, and establish a system to see that the objectives are carried out. Some of the objectives that might be set for an automation program are: 1. Cut costs 30 per cent. 2. Reduce accidents. 3. Reduce labor grievances. 4. Increase market penetration. 5. Cut work-in-process. 6. Eliminate the need for a new building. 7. Free skilled labor for other work. The last objective is prevalent in Europe. There, some companies are automating to reduce the skills required in their shops. They need the workers to expand, and they just can't be acquired in any other way.

The second requisite of a sound program is a good organization of technicians who are informed on new developments and who can analyze opportunities. In this group should be specialists who are qualified to deal with every phase of the business. It is only by co-ordination of such functions as marketing, product engineering, manufacturing research, production, accounting, and warehousing that the maximum benefits of automation are obtained. Cost reduction, reductions in skills, and other benefits are possible in all departments. For example, automobile companies are now studying ways and means of reducing lead time required to translate stylists' models into production tools. Everyone concerned agrees there will be savings in tooling costs and skills, but the real benefits will come from the reduction in lead time. This will permit much more reliable and dependable market forecasting. The savings that are possible through elimination of mistakes in this area are virtually unlimited.

A third requisite to a good program is proper phasing. Successful companies generally phase their automation projects as follows:

1. Make several feasibility studies to select the best method of accomplishing the objective.
2. Obtain an appropriation based on one of the feasibility studies.
3. Decide which parts of the project will be handled by the company, and which parts will be purchased from outside sources. Establish design and buy specifications. Set project standards.
4. Issue orders and followup.
5. Fabricate, install, and try out equipment; make necessary changes to overcome mistakes; train operators and maintenance personnel; and start operation.

The purpose of phasing is to provide check points along the way to see how well the project is meeting its specifications. Intermediate checks in some cases will eliminate costly mistakes, and save valuable time in completing the project.

The fourth requisite of a sound program is research in science, marketing, manufacturing methods, and human motivation. More effort is being devoted to research

and development today than at any time in our history. Every company that expects to automate must have the benefits of research as a source of new products, new manufacturing methods, and new business techniques. Every company can't have a large research organization, but research can often be obtained from private sources, schools, and colleges on a project basis. Some companies have pooled their resources to research certain subjects that were important to them. In many instances, these programs have been highly successful.

A fifth requisite to a sound automation program is a progressive depreciation policy. Depreciation provides one of the major sources of funds for automation. It is essential that capital invested in fixed assets be recovered as quickly as possible so that it can be reinvested for further growth.

A few years ago, tax laws in the United States were changed to provide a faster recovery of capital. Through the "sum of the digits" and the "declining balance" methods of depreciation, it is now possible to recover between two-thirds and three-quarters of an investment in the first half of the life of the asset.

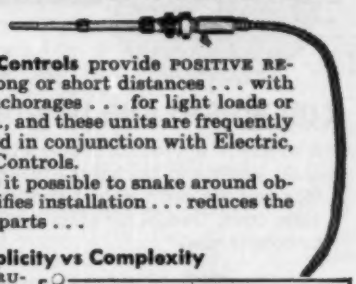
Unfortunately, even with these changes, capital recovery rates in the United States are the slowest of any industrial country in the world. It takes from 12 to 30 years to recover capital invested in machine tools in the United States as opposed to 4 to 8 years in industrial countries of Europe such as England, Germany, France, Sweden, and Italy. Automation will proceed at a faster rate if industry can persuade the Government to reform its tax laws to put us on a par.

A sixth requisite of a sound program is a good cost accounting system. Automation requires the forecasting of results of complicated operations. This is an extremely difficult task. For a forecast to be accurate, a tremendous amount of detailed information is required. One of the best sources of this information is a company's cost accounting records. Case histories from these records will provide the basis for reliable estimates. However, all too often the company's records do not provide the kind of information that is required. For example, in comparing the merits of two different kinds of machines it is important to know the cost of tool grinding, oil consumption, cleaning, repairs, etc., for each individual machine. Generally, these costs are buried in some overhead accounts. As a result, there are no reliable past history data available for the engineer to use in establishing estimates. Companies that do a successful job of automation have cost accounting systems that provide the data that are needed to assist engineers in projecting operations.

The last requisite is faith. Too many good ideas have been rejected with the comment, "it isn't economically justifiable." As a firm believer in the scientific approach, I am going to use economic analysis to justify many decisions—but this isn't the whole answer. There are times when faith is the only thing to go on. Where would we be today if men like Edison, Ford, Knudsen, Kettering, and many others had insisted on economic justification for their ideas before they went ahead? Courage of their kind is an important requisite of sound automation planning.

From a talk entitled "Planning for Automation" presented at the ASME National Production Engineering Conference, Detroit, May 1959.

Improved Operation of literally hundreds of mechanical products has been effected with Acco Tru-Lay *flexible* PUSH-PULL Controls



Tru-Lay Push-Pull Controls provide POSITIVE REMOTE-ACTION over long or short distances . . . with fixed or movable anchorages . . . for light loads or loads up to 1,000 lbs., and these units are frequently and successfully used in conjunction with Electric, Hydraulic and Air Controls.

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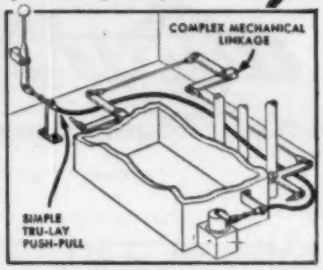
Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased backlash, lost accuracy and vibration rattles.



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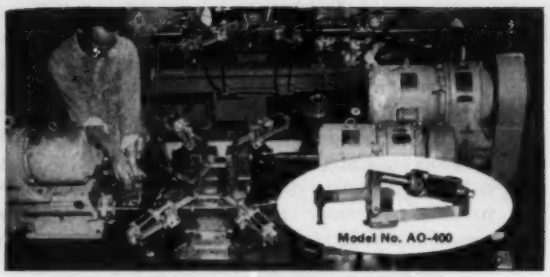

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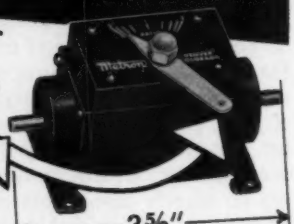

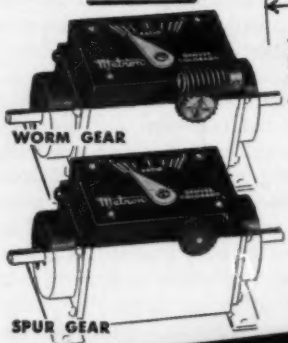

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Circle 716 on Page 19

are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 1989-P

HOT ITEM COUNTING

. . . We have a problem of counting a small plastic object as it comes from the mold, without orienting to insure interrupting a light beam. Product is approximately 300 F leaving the mold. Ambient temperature below the press is approximately 100 F. We would like to drop past a heat sensing device which would register regardless of product attitude. Information on heat sensing components and circuitry will be appreciated . . .

Experimental Engineer

CASE 1990-P

TILE HANDLING

. . . We manufacture glazed ceramic wall tile. Our 4¼-inch by 4¼-inch by 5/16-inch tile is semiautomatically loaded on a flat chain conveyor that takes it through our glaze application booths. After it is sprayed to proper thickness, this chain brings the tile, single file, in front of two takeoff girls. They stack it on trays for temporary storage and later it is loaded into kiln furniture for its second firing. To whom should we inquire to design and build an automatic machine that will transfer the tile from the chain to the kiln furniture at the rate of 200 pieces per minute? A piece of kiln furniture will hold 28 pieces of ware . . .

Industrial Engineer

CASE 1994-P

MAGAZINE HANDLING

. . . We need equipment that will build a stack of magazines, wrap them in kraft paper, and string or rope tie them. The stacks will average about 35 lb and magazines should be reverse piled in the stack. The stacks should be 6-side wrapped, but we might get acceptance of a 4-side wrap. It is our intention that the equipment be joined with suitable conveyors so that it will be unnecessary to handle the magazine from the time they are trimmed until they are delivered to the trucks. Can you advise us regarding manufacturers of equipment that would be adaptable to our problem? . . .

Production Engineer

SUGGESTION FOR 1903-P (SEPT. 1959)

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. . . Nothing is said about recording the signal on tape for the delay interval only. The tape delay itself should not be complex . . .

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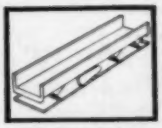
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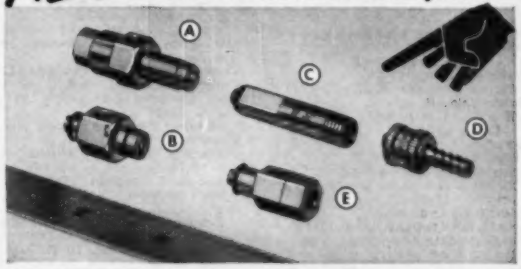

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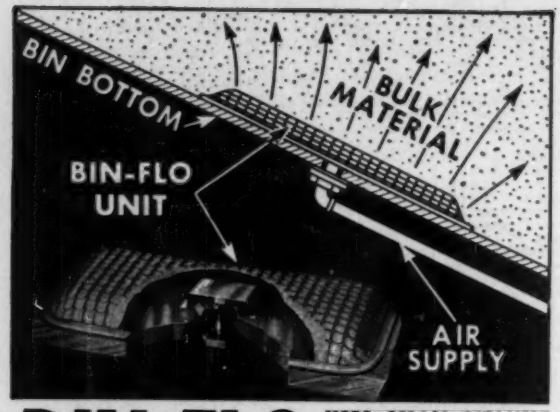

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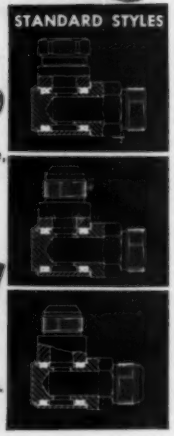

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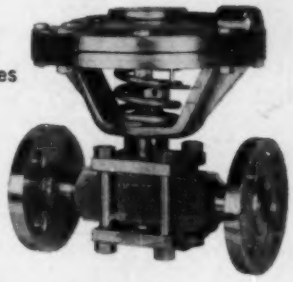
MINIATURE VALVES

501 Series

Valves shown ¼ Actual Size

526 Series



RUGGED

"BANTAM"

THROTTLING CONTROL VALVES

Compact throttling controls of the 501 series have one-piece barstock bodies with screwed ends and are available with linear, equal percentage or quick-opening plug characteristics. This series offers six operators, direct and reverse acting, including two with positioners.

The 526 series includes 6 body styles in globe, angle and 3-way design — with screwed or flanged ends. Four bonnet types cover standard, high or low temperature and packless applications. Six control operators are offered with up to 50 square-inch diaphragms.

	501	526
Pressure Rating	1000 psi (at 450°F)	1000 psi (at 450°F)
Temperature Rating	—70°F to +450°F	—70°F to +450°F (750°F with finned bonnet)
Maximum Cv.	0.63	10.0 (1" connections)
Lift	¼"	7/16"
Seat Area	0.038 sq. in.	up to 0.601 sq. in.
Connections	⅛", ¼", ½" N.P.T. Standard (others available)	¼" to 1" N.P.T. ½" to 1" flanged

Send for the BANTAM Catalog No. B-1 and other technical data on Dahl pneumatic and hydraulic valves.

George W. Dahl Company, Inc.
86 Tupelo Street
Bristol, Rhode Island

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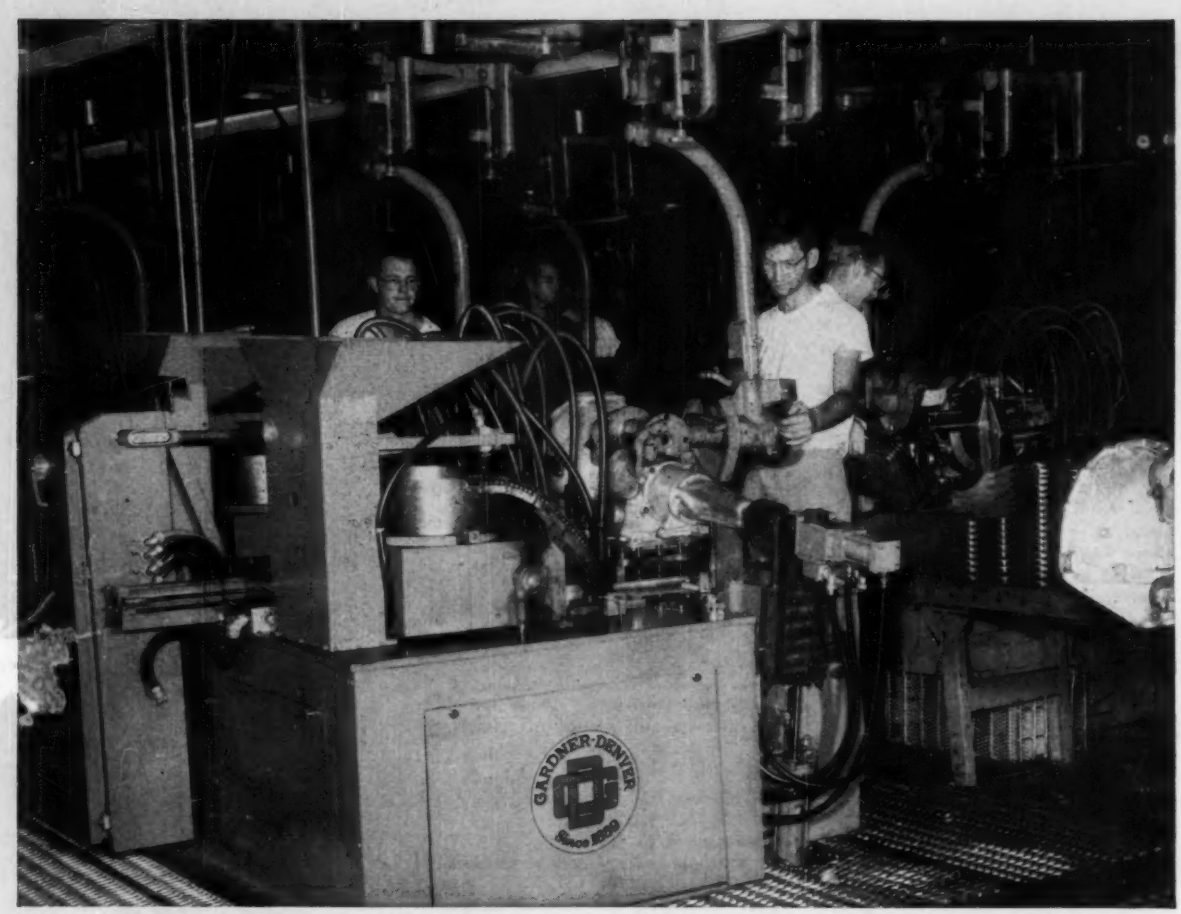
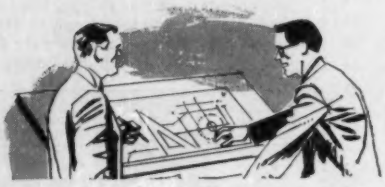


Ford speeds transmission production with special air-powered machines



IN INDUSTRY — SPEEDING THE PACE, the Gardner-Denver specialist is an integral part of the team. He works side by side with engineers and designers, helping to solve their problems. At Gardner-Denver there's no substitute for men—our 100-year philosophy of growth.

Three special pneumatic machines—designed by Gardner-Denver specifically for Ford Motor Company—step up production of automatic transmissions. These units automatically and simultaneously feed cap screws, hold and support the transmission, and set the screws on the oil pan assembly in a fraction of manual time.

This example is typical of the many tough problems that Gardner-Denver solves for production men. If you need a special multiple-spindle machine to speed assembly, Gardner-Denver specialists will work with your tool engineers to design and build one that exactly fits the job. Contact your Gardner-Denver representative for details.

GARDNER-DENVER Since 1859 — 100 1959 YEARS

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GARDNER - DENVER

Gardner-Denver Company, Quincy, Illinois

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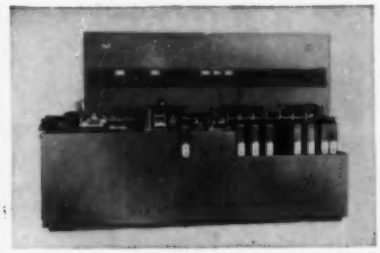
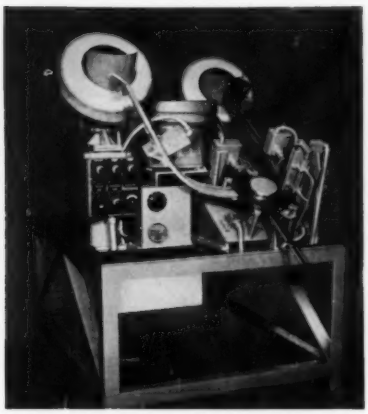
RCA "Building Block" Automation Equipment

Automatic High-Speed Hardness Testing Machines—Inspect up to 2500 parts per hour with laboratory accuracy.

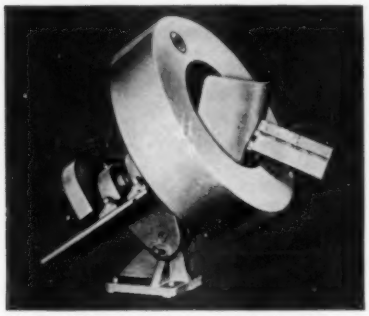
Centerless Grinder Control—Accurate to .000050", RCA self-compensating grinder controls can be used in rough as well as finish operations. Extreme reliability and 100% repeatability are reported by users.



Final Inspection Machines—Equipment similar to the one above, inspect O.D., I.D., length, taper, true roundness. They also provide automatic segregation of inspected parts into almost any desired number of categories, as well as stamping and counting.

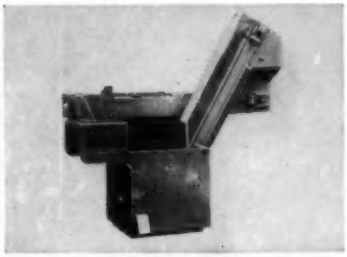


Automatic Assembly Machines—This unit automatically assembles bolts and lock washers. It is one of the many assembly machines developed by RCA.

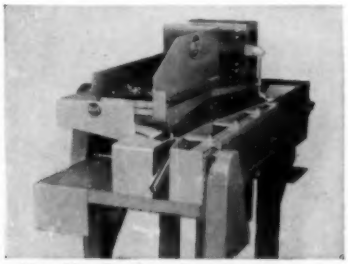


Rotary Hopper—Exceptionally low in cost, RCA rotary hoppers are available with 18", 24", and 30" bowls. RCA orienting discharge tracks for various part sizes and shapes are mounted on the hopper by merely loosening and tightening one screw.

Floor Feeders—High-Speed, "demand-feed" control, broad versatility in parts handled, and large storage capacity make these units ideal for integrating machine operations.



Elevating Orienting Feeders—"Demand-feed" controlled. Handle flat, cylindrical, rectangular and headed parts in a wide range of sizes.



Non-Mar Feeder—Provides "demand-controlled" oriented feeding of fragile or highly finished parts. A wide range of part sizes and shapes can be handled.

Whatever your requirements . . . a completely integrated automation system, or simple mechanization of individual operations, RCA's Industrial and Automation Division offers the most versatile range of such equipment available from any single source. All of these products have proved themselves in actual use. For details, contact your nearest representative or write to RCA.

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Size for Size...
New ASCO Midget 3 Way
Solenoid Valve
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Of Cylinders and Diaphragms

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